

SCIENCE.

FRIDAY, MARCH 14, 1884.

COMMENT AND CRITICISM.

IF one wishes to study man, it may be desirable to seek large cities, where men abound in great numbers and in almost infinite variety; but, if nature is to be questioned and cross-examined, it is wise to betake one's self to the fields, the woods, and the mountains, over which the artificial has not yet gained control. In the study of various problems in terrestrial physics, it is of the utmost importance to place the observing-stations so that they may fairly represent general conditions, and not be influenced by merely local disturbances; and it has long been customary to give such considerations proper weight in the selection of points at which various physical constants are to be determined. An article in the present issue, on the exposure of thermometers, furnishes evidence that it is quite possible for large cities to be fortunate in the possession of a climate which is largely artificial; that a meteorology which is based on observations taken under such artificial or peculiar conditions is likely, now and then, to go astray; and that in physics, as in politics, it is sometimes safe to await 'returns from the country.'

If the earth be represented by a globe sixteen inches in diameter, the largest city in the world will hardly be visible to the naked eye; and yet in most large cities there will be found to exist a set of meteorological conditions differing considerably from those of the surrounding country. It is not likely that difference exists alone in temperature, or that it is not noticeable, and worthy of serious attention, in other elements which go to make up 'the weather;' and it would appear desirable for working-meteorologists to agree upon some systematic plan of investigation which might

result in the determination of the proper location and exposure of their instruments, that they may more truthfully exhibit the average condition of the area which they represent.

THE close connection and interaction of religion, statescraft, and science in the modern world is illustrated in an interesting way in a recent number of the *Proceedings of the Royal Society of London*. The British government, desiring to introduce cheese-making as an Indian industry, was met by the difficulty that the religious beliefs of a large portion of the population of India placed an absolute veto on the use by them of cheese, in the manufacture of which rennet obtained from the stomach of an animal had been employed. The leaves of a species of *Pinguicula* are used by the Laps to coagulate reindeer-milk; and the government circulated in India a request for information as to any Indian plant which was known to have a similar property. Surgeon-Major Aitchison called attention to *Withania coagulans*, a Himalayan and northern India plant, the seeds of which were said to coagulate milk. A quantity of this material was sent from Kew to Mr. Sheridan Lea of Cambridge for examination. He was able to extract from it a ferment identical with the rennet ferment of the gastric mucous membrane of animals, and capable of preservation in solution as a commercial article in a similar way. The ferment exists in the seeds in considerable quantity, and is readily and cheaply extracted from them.

OF the 'change in the unit of time' controversy, to which we alluded in a late issue, there seems as yet no likelihood of abatement. Originally begun by Mr. Stone, lately her Majesty's astronomer at the Cape of Good Hope, it was at once participated in by Sir George Airy, the late astronomer royal, by Professor Newcomb, and later by a number of continental astronomers. When the Royal astronomi-

cal society met last autumn, Mr. Christie, the present astronomer royal, declared the subject "pretty well thrashed out, and quite unsuitable for discussion at their meetings." Since that time, both sides have had important accessions; no less a person than Col. Tennant, of her Majesty's mint, Calcutta, taking essentially the same view with Mr. Stone, and Professors Cayley and Adams coming forward with the clearest of proof that no such deviations as those indicated by Mr. Stone exist.

At first blush, it will seem very improbable that an astronomer of Mr. Stone's well-earned reputation for acuteness should get muddled in a matter of fundamental astronomy involving only simple algebra; but when he finds himself unable to clarify, after a half-dozen astronomers more able than himself have been endeavoring for six months to convince him of his fallacy, it can scarcely be called rash heterodoxy to suggest that an error on the part of his opponents may be at least among the possibilities. Although he is now aware that it may appear useless to continue researches of which the fundamental principle is disputed by astronomers of note, his latest utterance is, "I have not seen at present any evidence which weakens in the slightest degree my confidence in the accuracy of my results." It is very difficult for the non-mathematical to recognize the possibility of a mathematical dispute, even when the terms involved are of slight importance; but no sort of excuse can appear for a difference regarding a supposed discrepancy of this magnitude, involving the early disruption of fundamental tables of the celestial motions. Unless, then, this matter admits of speedy and permanent decision, the one way or the other, with the entire agreement of all parties to the controversy, astronomy would appear to run the serious risk of forfeiting her claim to a place among the exact sciences.

ONE of the indications of the activity in chemical matters in Germany may be found in the great prosperity of the Berlin chemical society. This organization dates only from

the year 1868, when it was started under the auspices of the Berlin chemists, headed by the genial Hofmann. In that year the volume containing the articles communicated to the society numbered only about two hundred and eighty pages. In a short time the society became a national instead of a local affair, fully deserving the name, '*Deutsche chemische gesellschaft*,' given to it at the outset. According to the last annual report, the number of members is now nearly three thousand; an increase of about two hundred having been made during the past year. The last annual volume published by the society numbers over three thousand pages. Of the members, eight hundred and forty-eight are foreigners; the largest number (one hundred and eighty-four) of these being English, while there are one hundred and forty-five Americans; and one hundred and forty-four Swiss, on the list. It will be seen that more than two-thirds, or about two thousand, of the members, are Germans.

It would lead too far to discuss fully the causes of the activity thus indicated. One of the most potent direct causes is, no doubt, the close bond of connection that has been established in Germany between pure chemistry and its industrial applications. While there is, perhaps, no country in which the maxim 'Science for the sake of science' is more frequently heard or more firmly believed in than in Germany, it is equally true that in this same country the most successful applications of the truths established by the votaries of pure chemistry have been made. Industries are there springing up every year, founded directly upon the most recent discoveries made in the university laboratories. Large numbers of thoroughly trained chemists are employed in the new factories. The value of science in carrying on industrial operations is fully recognized. It is certainly instructive to note that this state of things has been brought about by devotion to pure science. The much talked of 'practical man' who wants 'none of your theories' is not a common phenomenon in Germany.

THE notice in another column, of the pamphlet by Mr. Frank B. Scott, calls attention to a class of publications which belong to the idiosyncrasies of scientific writings. The law of variation among men involves the occasional occurrence of an extreme departure in any given direction from the normal average; and it is quite in accordance therewith that there should be from time to time a writer who seriously propounds startling views on a scientific subject about which he is ignorant. Such a person is one who is both very inexperienced and thoroughly unpractical, yet perhaps really intelligent. Something arrests his attention. He begins thinking about it, and finds a series of superficial or casual resemblances, which leads to a grand general conception. Startled and delighted, he eagerly hunts up some textbook: it contains no hint of the grand conception. The thought is then new. With feverish excitement, a few facts are patched together out of a fragmentary and too often inaccurate knowledge, and the idea is confirmed. The theory is then given to the world, condemned by the critics, laughed over as a choice bit by a few, and then forgotten according to its deserts. Fortunate is the author if he gains in experience what he does not secure in fame.

ATTENTION has recently been called to the bill for the establishment of 'national experiment-stations,' now pending before Congress, by a circular sent out by President S. A. Knapp of the Iowa agricultural college, who is the chairman of a committee appointed in January, 1883, by the U. S. department of agriculture, to have the matter in charge. The most interesting portion of the circular is, of course, the text of the bill. This provides for the establishment, at every agricultural college which possesses an improved farm, of a 'national experiment-station.' These stations are to be under the general control of the regents or trustees of the colleges where they are located; and the general character of the work to be done at each station is to be determined by the U. S. commissioner of agriculture, the president of the college, and the

director or superintendent of the station. The sum of fifteen thousand dollars is to be appropriated to each such station, but only so much of this sum is to be paid over to the station as will cover expenditures actually incurred.

The objects aimed at in this bill appear to be twofold, — first, to promote the advance of a scientific knowledge of agriculture; and, second, to unify to a certain extent the work of investigation now carried on at scattered and independent centres. To the first of these objects it would seem that no one could take exception. If it be admitted to be within the province of the national government to aid at all the advancement of science, it would certainly seem that a branch of applied science which touches the every-day interests of fully half our people, and which deals with a calling which is one of the chief sources of our national wealth, might reasonably claim a portion of that bounty which is so freely extended to other sciences, especially since the experience of Europe, and of several states in this country, has abundantly demonstrated the great utility of such stations. Certainly such an expenditure of the public money is at least as legitimate as river and harbor appropriations or arrears of pensions acts.

As regards the second object of the bill, while it may be desirable, it is not so certain that it can be readily attained. It may be lamentable, but it certainly is a fact, that scientific men do not work well in harness, and are apt to entertain extreme ideas of the value of personal independence in their work. Much would depend upon the character of the commissioner of agriculture. No man fit for the position of director of an experiment-station would be likely to consent to conduct that station according to a plan laid out in Washington. On the other hand, if the commissioner were a man whose personal character and scientific attainments commanded respect, he would have an opportunity which, if judiciously used, could not fail to bring honor to him, and profit to the interests of agriculture.

Should the bill pass, it is not impossible that one of its benefits might be, that it would render more difficult the appointment to the responsible post of commissioner of agriculture of individuals such as some who have in the past held without filling that position.

LETTERS TO THE EDITOR.

*** Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

Red sunsets and precipitation.

THE readers of the scientific journals have, no doubt, observed that the prevailing explanation for the red sunsets and colored sky during the past few months is that of chromatic diffusion of light by volcanic-ash particles. There are some apparent incongruities as pointed out by Mr. Proctor and others; but we believe that the established physical laws will permit a satisfactory solution of the phenomena, assuming volcanic matter as the cause.

The object of this letter is to notice what seems to the writer a probable connection between the conspicuous sunset colors and the excessive cloudiness and precipitation during the last month or six weeks. With regard to precipitation we must recognize Professor Aitken's discovery; viz., that clouds and all forms of precipitation occur by virtue of the solid particles of matter suspended in the atmosphere, serving as nuclei upon which the aqueous vapor is condensed. The supply of this solid matter in the aggregate is nearly uniform; but, if an excess occur from any cause, we should expect a larger precipitation for the same hygroscopic state of the atmosphere. This conclusion, we believe, has been verified during the past two months, in meteorological observations. It might be argued that the cloudiness and rain have not been evenly distributed, as would be expected if caused by the settling of the ash-particles; but in what has been said, no regard is taken of the various causes for an unequal distribution of the matter, and the common conditions of storms. We should expect weather-records to show the greater precipitation in regions where the sky colors have been most conspicuous. The writer, however, has no data for verifying this.

The above is advanced rather as a suggestion than as an exposition, in the hope that it may stimulate a more exhaustive study of this connection, if such there is.

W. H. HOWARD.

Does Unio spin a byssus?

Attached to the female of a *Unio* which I collected, last August, from the middle fork of the Holston River, at Marion, Va., were stones, some of them more than an inch in diameter. So strongly were these attached that not only could they be lifted from the water by the attachment, but it took considerable force to separate them from the *Unio*. I had often seen *Unio* shells covered with gravel and mud firmly cemented by the *Confervae* that commonly grow upon the anterior portion of the valves exposed above the water; but these shells under consideration were unusually free from such growths. At the time, I removed the pebbles without giving attention to the phenomenon; but, recurring to it afterwards, I found, on examination, what appeared to be the bases

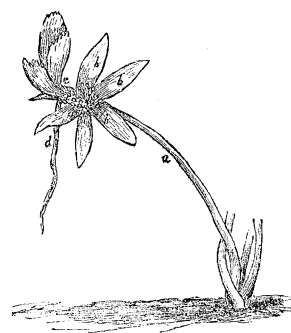
of *byssi*, situated at about the middle of the anterior fourth of each valve.

Again: these were only found on females, all of which were gravid, having the eggs well developed. Is it a provision to prevent the strong current of this river from sweeping them into unsuitable spawning-grounds while depositing their eggs? Are these *byssi* (?) seasonal, or permanent? If *byssi*, how are they spun?

E. P. LARKIN.

Retrograde metamorphosis of a strawberry-flower.

Mr. J. H. Foster of Orange county, Fla., sends a monstrous form of a strawberry-blossom, which is shown in the accompanying engraving. During the winter there were several hard frosts which blasted many of the strawberry-flowers in Florida. This injurious weather may have been the cause of the strange malformation. The engraving shows the flower-stalk,



a, raised from its reclining position. The calyx-lobes are at *b*, *b*, and within these is a circle of stamens. In place of the fleshy receptacle, so much relished by all when ripe, there is a small strawberry-plant, *c*, with its short stem, and a root, *d*, springing from near its base. This root, doubtless, penetrated the soil soon after it started out from the stem, and became a source

of nourishment for the young plant. The base of the stem has many undeveloped pistils scattered over its surface, which plainly show that the plant is a transformed receptacle. The young leaves, when unfolded, are of the normal form, consisting of three wedge-shaped, coarsely serrated leaflets.

Flowers, and in fact all organs of plants, have been known to undergo strange changes of form. All gradations may be found, from one set of floral organs to another. This is seen between petals and stamens in almost every white water-lily, and between stamens and pistils in willow, apple, poppy, and other blossoms. Stamens are changed into, or become, petals in the familiar process of the 'doubling' of flowers. This tendency to retrograde is carried still farther when both the stamens and pistils become green, leafy expansions, and thus reveal their true nature. In many cases the floral axis is prolonged beyond one or more circles of floral organs, and the stem again assumes the ordinary leaf-bearing form. Such a metamorphosis sometimes takes place in an apple or pear blossom; and as a result, there may be a fully developed fruit, with a leafy branch extending beyond the blossom end (basin).

The metamorphosis which has taken place in the strawberry-flower shown in the engraving is in the line of our expectation: the strawberry-plant propagates itself readily and rapidly by slender branches sent off from the base of the parent-plant. Each one of these runners strikes root at its apex, and soon develops a tuft of leaves and an independent plant. In the case discovered by Mr. Foster, this strong tendency to increase by runners is carried out by a flower-stem with a frost-injured blossom lying upon the moist earth.

BYRON D. HALSTED.

The reproduction of *Clathrulina elegans*.

In *Science*, iii. 55, is published a *résumé* of Miss S. G. Foulke's remarks before the Philadelphia academy of natural sciences in reference to the reproductive methods of *Clathrulina elegans*; her statements being apparently confined chiefly to a process by quadruple subdivision of the body into uniflagellate organisms as observed by herself, with allusion to three additional processes as observed by others. In August, 1881, the writer repeatedly witnessed two forms of reproduction with this rhizopod, in some respects quite different from what was observed or mentioned by Miss Foulke.

The body of *Clathrulina* in no instance withdrew its rays before subdivision, but underwent transverse binary fission; each part, even after complete separation, retaining its pseudopodal rays fully extended. Soon after dividing, however, one part became perfectly smooth, having possessed up to this point a conspicuous pulsating vacuole, which now curiously contracted, and did not re-appear. The remaining half of the original body underwent no change except that caused by the protrusion of rays from the freshly divided surface.

The recently separated portion then slowly passed out of the capsule, forming, just before its escape, two vibratile flagella of unequal length. Its movements began immediately, being only moderately active, and continuing for less than two minutes, when it suddenly lifted itself upon the flagella-bearing end, and instantaneously collapsed into a shapeless mass studded with short blunt pseudopodia, which almost as quickly became filiform; and the zooid was an Actinophrys-like creature, with two flagella trembling at its front. The latter were soon lost among the rays, and the animal at once began to form the pedicle by a slow extrusion of the body-sarcode. The whole process consumed about three hours.

From the same gathering I was also fortunate enough to learn how *Clathrulina* produces the colonies occasionally met with. The process, up to the escape of the biflagellate zooid, even with the strange conduct of the contractile vesicle, was as just described. The longer of the flagella, however, terminated in a conspicuous bulb-like enlargement, which remained within, but was not attached to, the parent-shell. The vibrations of the short lash gave the zooid a rapid rotatory and oscillating movement, the anchoring bulb slipping freely from side to side of the opening in the lattice. Motion continued for perhaps five minutes. The obovate body then became rounded, the smooth surface roughened by irregular protrusions extending into filiform rays, until another flagellate Actinophrys-like creature appeared, loosely anchored to a *Clathrulina* lattice. It remained motionless on the extremity of the apparently rigid bulb-bearing lash, which I supposed would become the pedicle; but in a few moments an unusually thick pseudopodium was extruded, and attached by an expanded base to the capsule. On this the Actinophrys, with all its rays extended, was slowly lifted to the required distance above the parent; while the anchoring flagellum became more and more attenuated, the bulb less and less noticeable, until both finally disappeared.

It seems, then, that *Clathrulina elegans* has six reproductive methods, — "by self-division, by the instantaneous throwing-off of a small mass of sarcode, by the formation and liberation of minute germs," by the quadruple subdivision of the body into uniflagellate organisms, by the separation from the body of a free-swimming Heteromita-like zooid for the dis-

semination of the species, and by a similar body-fission whose resulting biflagellate organism is anchored to the parent-capsule for the formation of a colony.

DR. ALFRED C. STOKES.

Trenton, N. J.

Formation of anchor-ice.

On the 17th of January, this year, I had occasion to cross the River St. Lawrence in one of the small Indian ferryboats which ply between the Indian village of Caughnawaga, on the south shore, and Lachine, on the Island of Montreal. The current of the river at this point flows at the rate of four or five miles an hour, I think, and never freezes over. The day was quite stormy, the thermometer indicated about 12° or 15° F.; and the river was pretty thickly covered with cakes and masses of porous or very snowy ice. But the most peculiar phenomenon was the sudden and almost incessant rising of dark, muddy ice from the bottom of the river. The formation of this ice so far below the surface of the water is supposed to take place in very cold weather, when large masses of snow, descending the river, become saturated with water, and are carried by the current to the bottom, where they stick to the rocks and stones, clinging more firmly and becoming more compact as long as cold weather continues. At least, this is the theory that the Indians advanced. The ice may be seen six or eight feet under water, and often accumulates until it forms miniature islands. When it rises, it often lifts considerable quantities of small stones and gravel to the surface.

Another peculiar circumstance is, that this rising of the ice from the bed of the river always occurs a day or two before the approach of mild weather; and the Indians regard this phenomenon as an infallible presage of milder weather within forty-eight hours. The cause is most likely atmospheric, but I record the observation with the hope that it may be a hint to some one willing to make a further study of the subject.

J. G. J.

Chateauguay Basin, P. Q., Canada.

Manayunkia speciosa.

In this worm, described and figured by Leidy (*Proc. acad. nat. sc. Philad.*, 1883), the tentacular crown, or branchial organ, is the feature of special interest.

According to Leidy, the tentacles present in an adult are eighteen in number, besides two larger and longer tentacles situated dorsally, midway between the two lophophores. These larger tentacles are conspicuous by their bright green color, and are, in fact, external continuations of the blood-vessels extending lengthwise throughout the body. In shape these tentacles taper from base to apex, are convex on the outside, but concave on that side facing the centre of the tentacular crown; so that a transverse section would present the shape of a crescent. The two longitudinal edges thus formed are fringed with cilia. When closely watched, the green tentacles are seen to pulsate with a rhythmical motion, contracting and expanding laterally. The pulsation takes place in each tentacle alternately. At the moment of contraction the tentacle turns slightly on its axis outwards, and towards the end of the lophophore on that side, at the same time giving a backward jerk, returning to its former position at the moment of expansion. By force of the contraction the green blood filling the tentacles is forced downwards, out of the tentacle, and flows along the blood-vessel on that

side of the body. On the expanding of the tentacle the blood instantly returns, and suffuses it; and thus the process goes on. The contraction and expansion occur at regular intervals, together occupying the space of two seconds. It is in this way that the blood is purified and the circulation controlled. The above observations were made with a seven-eighths inch objective; the subject being placed in a zoöphyte-trough.

To ascertain how long the cilia upon the tentacles would continue their motion after separation from the worm, both lophophores of an adult were cut off above their own junction. At first the tentacles remained closed; but soon they expanded, the cilia displaying active motion; and presently the two separated lophophores began to move about in the zoöphyte-trough. This motion was produced by the action of the tentacles, which bent in all directions, their tips touching the glass, and was not a result of ciliary currents. In a few minutes one lophophore had *crawled* in this manner quite across the trough, while the other remained floating in the water near its first position. Sometimes the motion was produced by ciliary currents, the tentacles remaining motionless; but this was quite distinct from the *crawling* above noted.

During this time the decapitated worm had sunk to the bottom, and, though twisting and turning a good deal, did not attempt to protrude the mutilated support of the lophophores. Its body was so much contracted that the segments were not above one-third their usual size.

At the end of five hours the worm was apparently dead; numbers of infusoria had collected to prey upon it; and the surface of its body presented a roughened appearance, as though covered with tubercles. The lophophores were still in motion. At the end of the eighth hour the lophophores had ceased to move, and were paler and more transparent; but the ciliary action, though feeble and uncertain, still continued. The body of the worm was then covered with a thick fungoid growth, consisting of transparent, rod-like filaments, three-sixteenths of an inch in length, some of the filaments having a beaded appearance. All motion of the cilia upon the tentacles had now ceased, and these latter were also the prey of infusoria.

The above experiment showed that the independent motion of the cilia continued about twice as long as the mutilated worm gave evidence of vitality. Several individuals of *Manayunkia* were observed to be preyed upon while still alive by large monads, embedded in one or more segments, which were sometimes excavated to a considerable degree.

SARA GWENDOLEN FOULKE.

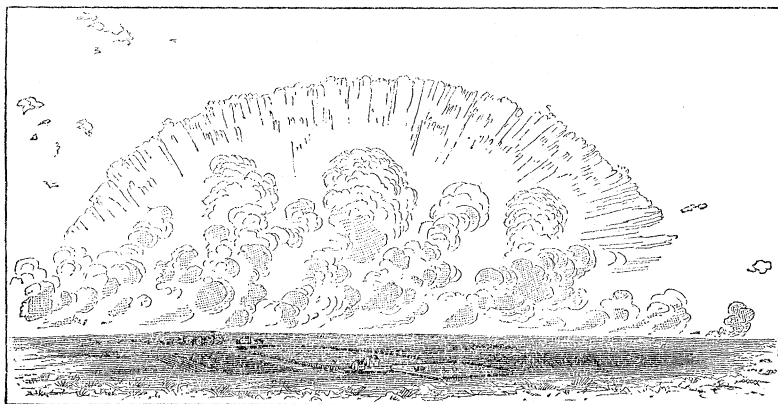
Appearance of the cyclone cloud at Rochester, Minn., 1883.

On Tuesday, Aug. 21, I left Minneapolis at three o'clock in the afternoon for Albert Lea, Io.

Late in the afternoon my attention was attracted

to a remarkable storm-cloud that lay along the eastern horizon. As the sun grew low in the west, this cloud assumed most extraordinary proportions and colors; so much so, that it attracted almost universal attention. A strange, fan-like sheet of yellowish cloud, with broken but decided margin, rose above the centre of the storm like a great halo. It did not seem to stand in a vertical position, but projected above, toward the west, giving the effect of a huge funnel, viewed from below, on the exterior surface of which the descending sun cast shadows, and brought out a sort of radiate ribbed structure.

Beneath this was a great cluster of swelling cumulus 'thunder-heads,' whose bases were hidden by the horizon. Three of these, higher than the others, rose vertically from the centre of the mass; their magnificent fleece-like heads entering and apparently penetrating the yellow halo. These, especially the middle and largest one, glowed brilliantly in the strong sun-



light, and cast long blue shadows down the inclined under-surface of the halo.

Encircling this brilliant mass were a number of enormous 'thunder-heads' of a most murky and forbidding appearance, that stood upright, like so many pillars of dense smoke. These upright clouds inclined a little to the east or south-east, indicating a movement in that direction.

There was a remarkable stability about the whole mass of clouds, and at sunset the effect was grand in the extreme. The sky about was clear, with the exception of isolated masses of cumulus-cloud.

I made a small pencil-sketch of the cloud-forms, with notes of color, and, since my return to Washington, have made a drawing in color.

I estimated that the cloud was from forty to fifty miles east of the railway, and, on studying the map carefully, became convinced that this was the cloud attending the great cyclone at Rochester. My attention was not called to the cloud until after five o'clock, at which time it was directly east of me, at Wilton. As the course of the cyclone was a little to the north of east, the movement was directly from me when the sketch was made.

The peculiar form of the halo, whether fan or funnel shaped, was doubtless, in a measure, the result of the movements of the storm-currents.

W. H. HOLMES.

Geological survey, Washington.

Stones placed in pine-trees by birds.

About seventy-five miles south of the United States boundary, near this place, at an elevation of six thousand feet, is a stretch of table-lands covered with large pines (*Pinus jeffreyi*?), broken by many ridges of giant granite boulders, decomposing sufficiently to add materially to the soil. Broad, grassy meadows furnish food for cattle and deer.

My father and myself, in riding through this forest in July, 1883, noticed several pines with the bark bored into at varying distances from the base of the tree to the branches; and in about one-third of the holes were the acorns of the here common *Quercus emoryi*, very tightly fitted, the holes containing the acorns apparently newly made. The remaining holes were weather-beaten; and in them were equally tightly fitted bits of the granite gravel, of size corresponding with the acorns in the other holes. In the Cuyamaca Mountains, of this county, a gentleman observed *Colaptes auratus* visit pines that contained similarly disposed acorns. The woodpecker tapped the acorns, breaking one now and then; the broken shells showing plain traces of having contained a worm, while the other acorns contained sound kernels. But what object could the birds have in substituting stones as shown above? Possibly they served as hiding-places for many insects which would otherwise have secured places inaccessible to the birds. C. R. ORCUTT.

San Diego, Cal., Feb. 16.

How a spider sometimes lifts heavy objects to its nest.

Last summer, while at Lynchburg, Va., I observed a spider—probably an *Epeira*—spinning a thread down from the upper section of a large fountain on the lawn of the Arlington hotel. He was some eight feet from the surface. I watched him descend to the water, where he captured a beetle that had unfortunately fallen into the large basin. The beetle must have been an inch long. Our *Epeira* made a turn of his line around his captive, and ascended all the way to his nest; immediately descending, he threw another loop around his prey, and again ascended to his nest, continuing this process for full ten minutes: to my surprise, while the spider was at his web, apparently overhauling and tightening the several threads that he had spun to and from the beetle, it left the water, and, evidently by elastic contraction of the threads, ascended full an inch from the surface. The spider spun down another lasso, and threw it round his victim, then retired and was busy with his lines, when the beetle again moved upwards. These operations were repeated, until, at the end of forty-five minutes, he had snugly secured his prey in his nest, at a distance of at least eight feet from the water, by this curious and interesting method.

Cambridge, March 3.

E. P. LARKIN.

The use of the method of limits in mathematical teaching.

I notice in a recent number of *Science* a proposal to discuss the different methods of teaching the elements of the infinitesimal calculus and, in connection with this, an allusion to Professors Rice and Johnson's 'New method of rates.'

I trust it is not out of place to suggest that the method in question seems to me very like the method given in Maclaurin's 'Fluxions,' which the author attributes, at least partially, to Newton; and that the present very general use of the method of limits is probably a case of 'the survival of the fittest:' for I have found in my experience as a teacher that those

who are either too young or too slow to acquire at once the deeper conceptions of mathematics are often capable of doing very good work when the demonstrations are adapted to their comprehension.

The method of limits seems to me that which must be used with a class, if it is desired to give a sure foundation to as many as possible; the method of rates or fluxions requires rather more preparation of mind; and the infinitesimal method is best adapted to those who have mathematical genius.

The average engineer or architect is a person whose natural bent is towards construction and the use of tools. Such a person will, in all probability, require the infinitesimal calculus as a tool rather than as a recreation or a profession, and should therefore be trained by a slow and certain process—like the method of limits—in order that his real abilities may not be disguised by any slowness of comprehension in a matter which he can by patience acquire.

The weakness of mathematics as a general study in our institutions lies in the rapidity with which the successive steps are passed over; so that the slower pupils are left behind, and become discouraged. Old country schools do more solid work in average cases.

TRUMAN HENRY SAFFORD.

Williams college, March 1.

THE INTERNATIONAL BUREAU OF WEIGHTS AND MEASURES.¹

THE annual report of operations for 1883 has just been received. It shows a steady advance towards the completion of the international standards. All the principal instruments and apparatus have now been procured, and are in position. The *comparateur géodésique*, for which a contract was made with the *Société Gènevoise* in 1882, was to have been delivered by August of last year. Various events conspired to delay its complete delivery; but at the close of the report the entire apparatus was on its way, and was to be set up in the early part of January. All necessary masonry work was done in the spring of 1883.

Changes have been made in the method of heating the room of the Brunner comparator. Hitherto it has been done by regulating the temperature of water held between the double zinc walls in which the room is enclosed. It has been found, however, that, in addition to the difficulty and expense of maintaining a constant temperature of the water day and night, trouble was experienced from frequent leaks in the zinc walls, necessitating repairs, and stopping the observations: consequently the maintenance of temperature by the use of hot water has been discontinued; and for it has been substituted hot air, which so far has proved satisfactory, and which, it is hoped, will solve the problem of heating.

¹ Comité international des poids et mesures. Septième rapport au . gouvernements signataires de la convention du mètre sur l'œuvre de 1883. Paris, 1884. 54 p. 4°. See also *Science*, No.

Observations made in the upper vault, five metres under ground, show that the daily variation of temperature is insensible, and that the annual range is only a few degrees. As it is apparently water-tight, it will serve as a safe place of deposit for the standards. In the lower vault, ten metres under ground, the temperature is steady at 11° C. throughout the year. At present there is trouble from moisture. Steps are taking to overcome this difficulty; and, when they are complete, the chamber will be ready for the reception of the prototypes.

The examination of the universal comparator has been completed, and all values determined save the final errors of division of the two-metre scale. Certain auxiliary scales needed for this work were ordered, and have just been received.

Modifications are being made on the Brunner comparator to admit of comparisons of metres under water.

The report for 1882 showed that the balance for vacuum-weighings had been received; but certain defects of construction were found to exist, and it was returned to the makers to have them remedied. It was again received last autumn, and now appears to maintain a vacuum in a satisfactory manner. Its examination, and the determination of its instrumental constants, will be immediately begun.

The manufacture of the standard metres and kilograms by Johnson, Matthey, & Co., is progressing. Analyses of the alloy show it to fill all requisite conditions. Up to the present time the progress has necessarily been slow, as the important questions of alloy, refinement, and mechanical execution, had to be provided for. These matters have now been satisfactorily settled, and the delivery of the bars and ingots may be expected soon to begin.

In the report of the operations during 1882 was given an account of the copies of the *mètre des archives* and of the *kilogramme des archives*, which, on April 26, were confided to the care of the director of the bureau. Although rigorously compared, and the relation to the standards of the archives accurately determined, these were not adopted as international prototypes, but were deposited as witness-copies of these standards. The kilogram, K_{III} , elaborately compared with the *kilogramme des archives* in 1882 and 1883, was found to be identical in value thereto; and on Oct. 3, 1883, it was formally adopted as the international prototype of the kilogram.

During the year, changes have taken place in the *personnel* of the international committee

and the bureau. The Turkish member of the original committee having taken no part in its deliberations since its organization, and repeated attempts to ascertain his future intentions in the matter having failed, his place has formally been declared vacant. The vacancy as yet has not been filled. The resignation of Mr. Marek as a member of the international bureau took effect from March 1, 1883. Dr. Max Thiesen of Berlin was chosen as his successor, and is charged with matters relating to weighing.

The second volume of the *Travaux et mémoires* has appeared, and contains a number of important papers relating to comparisons and to determination of coefficients of expansion. The third volume is in press, and in great degree printed. It is expected to appear in a few months. The material for the fourth volume is in large degree prepared.

Although the comparison of the international standards has not yet begun, a number of national standards have been compared, and important physical investigations made.

Comparisons of much interest to Americans are those between the British platinum kilogram and a platinum-iridium and two brass avoirdupois pounds and the prototype kilogram, as through them our own weights are brought into more direct relation with the international standards. Also a steel metre belonging to the U. S. lake survey has been compared for length and coefficient of expansion.

Experiments with the Fizeau expansion apparatus have given a new and elaborate determination of the change, with temperature, of the index of refraction of atmospheric air; and the coefficients of expansion of many minerals have been determined. An elaborate redetermination of the wave-length of the sodium-ray is in progress.

Correspondence is in progress with Mexico with a view to the adoption, by that government, of the articles of the metric convention.

H. W. BLAIR.

A QUESTION OF EXPOSURE.

The extraordinary depressions in temperature, which occurred in the month of January in many parts of the country, have attracted an unusual amount of attention to questions of thermometry. In some instances it has been observed that the areas of excessive cold were smaller than might have been anticipated, great differences often existing where there were no

geographical or topographical reasons for them. A comparison of reliable observations, made during this period, furnishes evidence of the great importance of considering the situation and exposure of thermometers.

In the state of Ohio, there were three distinct periods of great depression during the month; and at two of these the minimum temperatures were unprecedented in the history of the state. The important fact, however, to which it seems desirable to call attention, is that the records of the U. S. signal-service observers contain no account of these extraordinary cold-waves; and we should be ignorant of their existence, if obliged to depend for information upon these records alone. This fact can be attributed, in some degree, to the small number of regular signal-service stations in the state, but in a far greater degree, in the opinion of the writer, to the situation and exposure of the thermometers of that service.

The Ohio meteorological bureau has more than twenty observing-stations, pretty well distributed over the state. The observers are generally persons of more than ordinary intelligence, and many of them have had long experience in meteorological observations. The instruments which they use are of the best pattern, being similar, in fact, to those in use by the U. S. service; and all have been compared with the standards at Washington, through the kindness of the chief signal-officer, and their errors are in most cases very small.

The U. S. signal-service has four regular stations in Ohio, situated at Toledo, Cleveland, Columbus, and Cincinnati. A station at Sandusky has recently been re-established; but reports have not been received from that station, for the month of January, by the Ohio bureau.

The first cold-wave was most severe on the 5th, 6th, and 7th. On the 5th the mean minimum for the state, from the observations of the State service, was -16° ; and from those of the U. S. service it was -12° . The lowest temperature recorded by the State service was -24.4° ; and by the U. S. service it was -16.3° . On the 6th the mean minimum and the lowest temperature, as recorded by the State service, were -15.3° and -24.6° respectively, the corresponding numbers from the records of the U. S. service being -12.2° and -20.3° . On the 7th the difference was still more marked; the numbers being -11.6° and -19.6° for the State service, and -2° and -7° for the U. S. service.

The second great depression was of short duration, and was most severe on the 21st. On that day the mean minimum for the state, from

the State-service observations, was -11.1° , while from those of the U. S. service it was $+1.4^{\circ}$. The lowest temperature recorded by the State service was -31° , and by the U. S. service was -3.7° . These minima were recorded at the same place, Columbus; the distance between the stations being slightly less than three miles. It seems difficult to understand how two stations so near to each other could furnish results differing from each other so greatly.

The question appears to be purely one of situation and exposure. The U. S. signal-service thermometers are exposed in a box or case of the usual form, attached to the north side of a stone building in the centre of the city: those of the State service are exposed in a somewhat similar shelter, but in an open space on the campus of the Ohio state university, at a considerable distance from any building. The conditions on the night of the 20th and 21st were peculiarly favorable to the production of such a result as that given above. During the 20th the temperature was not very low; and in the evening and night the sky was clear, and there was scarcely any movement in the atmosphere. The rapid fall in temperature was unaccompanied by movement of masses of air; and, as a result, the air confined in the shelter of the U. S. service thermometers was not displaced; and, being in contact with a large building which lost its heat slowly, the fall in temperature was not great. Had there been a brisk wind, or even a breeze, the result would have been different. The minimum of -31° , recorded by the State service, cannot be questioned; as it was supported by numerous readings from 'private' instruments, equally reliable, in the immediate vicinity and in the neighborhood of the city. At Westerville, twelve miles distant, a minimum of -24° was recorded by one of the observers of the State service.

Nearly as great a difference was exhibited in the records of the 25th. For this 'dip,' which was the lowest of the three, the mean minimum for the whole state, as obtained from twenty-two stations of the State service, was -19.8° , while from the records of the U. S. service it was only -5.1° . The lowest temperature observed by the State service was -34° , while the lowest reported by the U. S. service was -15.1° .

These comparisons lead to some conclusions which are certainly not without importance in the study of climatology. In these instances it appears that the U. S. signal-service has failed to obtain the mean lowest temperature

by from 3° to 15° , and that it has missed the minimum on different days by 5° , 8° , 13° , 19° , and 27° .

Improper exposure of thermometers will account for a part of this discrepancy; and it is well known that the chief signal-officer has already recognized the importance of this point, circulars having been distributed, some months ago, to all volunteer observers, requesting detailed information concerning the manner and method of exposure. The location of the station appears to the writer to be of even greater importance. It is unfortunate that nearly all stations of the U. S. signal-service are in large cities, and often in the most densely built and populated portion of them. Concerning temperature, at least, it is not likely that such situations will give results of great value, even with the most careful attention to exposure.

From geographical and topographical considerations, the station at Columbus is more likely to fairly represent the state of Ohio than either of the others; but the above observations show that it may fall far short of doing it. Observations taken at Cincinnati represent little more than the conditions in that city, the topography of that region being such that the city might almost be said to have a climate of its own. One of the State-service stations is at Waverly, the latitude of which is very nearly the same as that of Cincinnati. On the 21st, Waverly reported a minimum of -14° , and Cincinnati, of $+7.9^{\circ}$; and on the 25th, Waverly reported -27.2° , and Cincinnati, $+3.7^{\circ}$. In Cleveland and Toledo the climate is modified greatly by the presence of Lake Erie. At Wauseon, thirty miles from Toledo, the minimum is reported on the 25th as -31.7° ; and at Toledo it was -9° .

There are, doubtless, excellent reasons why these stations should be where they are, and also why it is generally desirable to locate stations in large cities; but there seems to be little doubt that for temperature measurements it would be well to put stations *near* rather than *in* large cities, and at sufficient distance from them to be free from purely local conditions.

The importance of the maintenance of state weather-services is not so generally appreciated as it deserves to be. It is impossible for the U. S. service, at least at present, to increase the number of its stations to the extent that would seem desirable and necessary in order to obtain the details of climatic conditions. The organization of state services is generously encouraged by the chief signal-officer; and if they become general, and are efficient, they may be of great service to the very competent

corps of government meteorologists in their investigation of general problems in climatology.

T. C. MENDENHALL.

IRON FROM NORTH CAROLINA MOUNDS.

IN the Proceedings of the American antiquarian society, vol. ii. p. 349 (1883), Professor Putnam reviews the statements of the old writers respecting metal found in the western mounds. He comes to the conclusion that Mr. Atwater's iron-bladed sword or steel-bladed dagger is to be traced to that gentleman's lively imagination.

Although Professor Putnam may be correct in his conclusion, a discovery made in North Carolina by one of the assistants in the Bureau of ethnology, during the past season, would seem to render the statement made by Atwater in regard to finding the fragment of an iron sword-blade in an Ohio mound at least probable.

In order that the reader may understand the conditions under which the articles to be mentioned were found, it is necessary to give a description of the burial-place, which I do by copying the report of the assistant.

"This is not a mound, but a burial-pit, in the form of a triangle, the two longest sides each

forty-eight feet, and the base, thirty-two feet, in which the bodies and articles were deposited, and then covered over, but not raised above the natural surface. The depth of the original excavation, the lines of which could be distinctly traced, varied from two and a half to

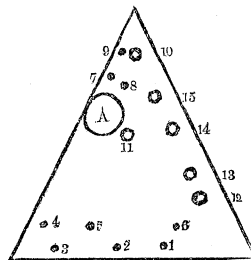


FIG. 1.

three feet. A rude sketch of this triangle, showing the relative positions of the skeletons, is given in fig. 1.

"Skeletons Nos. 1, 2, 3, 4, 5, 6, 7, 8, and 9 were lying horizontally on their backs, heads east and north-east. By No. 2 was a broken soapstone pipe; by No. 5 and also by No. 9, a small stone hatchet.

"Nos. 10, 11, 12, 13, 14, and 15 were buried in rude stone vaults built of cobblestones similar to those in fig. 2, which represents the arrangement of the bodies and vaults in a mound near by. (This mound was over a circular pit.) Nos. 10, 12, 13, and 15 were in a sitting-posture, and without any accom-

panying articles. Graves Nos. 11 and 14 contained each two bodies extended horizontally,—the lower ones, which were of smaller stature than the upper ones, face up, and with heavy flat stones on the extended arms and legs; the upper ones with the face down; no implements or ornaments with them.

inscribed shells were found. Scattered over and among these ten or more skeletons were found hatchets (polished axes and celts), rubbing and discoidal stones, copper arrow-points, mica, paint, black lead, etc.”

This is sufficient to indicate the conditions under which the iron specimens were found.

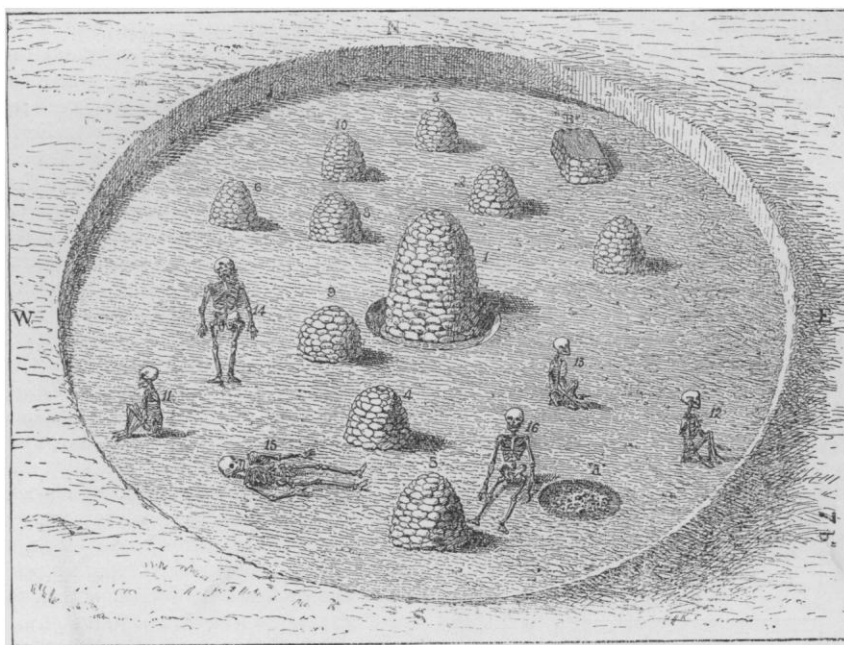


FIG. 2.

“On the north-west side of the triangle, at A, fig. 1, ten or more bodies were found which appeared to have been buried at one time; the old chief (?) with his head north-east, face down. Under his head was the larger sea-shell with hieroglyphics. Around his neck were the largest-sized beads. At or near each ear were the larger pieces of copper: there was also a piece of copper under his breast. His arms were extended, and his hands rested about one foot from each side of his head. Around each wrist was a bracelet composed of long, cylindrical, copper beads and shell beads alternated. *At his right hand were found the implements of iron.* Under his left hand was a sea-shell with hieroglyphics inscribed on the concave surface, and filled with beads of all sizes.

“Around and over him, with their heads resting near his, were placed nine or more bodies. Under the heads of two of these skeletons, resting within a foot of the chief’s (?), similarly

It is proper to state that every article named was immediately forwarded to the bureau, and is now in the National museum. The celts and axes, which are chiefly of greenish sienite, are highly polished, and equal in finish to the finest hitherto discovered in this country. The pipes are well made, and mostly well polished. The engraved shells are fine, large specimens, the engraved design on each being of the same type as that shown in fig. 3, plate xxx., of Jones’s *Antiquities of the southern Indians*.

The iron specimens alluded to are now before me, and are four in number, much corroded, but still showing the form. Two of them are flat pieces, of uniform thickness, not sharpened at the ends or edges, three to three and a half inches long, one to one and a half inches broad, and about a quarter of an inch thick. Another is five inches long, slightly tapering in width from one and an eighth to seven-eighths of an inch, both edges sharp, and is, without doubt, part of the blade of a long, slender, cutting or

thrusting weapon of some kind; as a sword, dagger, or large knife. The other specimen is part of some round, awl-shaped implement; and a small fragment of the bone handle in which it was fixed yet remains attached to it.

The bureau is also in possession of another rudely hammered, small iron chisel or celt, found under somewhat similar conditions in a mound in the same section.

It is evident, from what has been stated, that we cannot ascribe the presence of this metal to an intrusive burial. The people who dug the pit, deposited here their deceased chief, or man of authority, and placed around him, and those buried with him, the pipes, celts, axes, engraved shell-gorgetts, and other implements and ornaments, undoubtedly placed here, also, the pieces of iron.

Whether the burials were comparatively modern or pre-Columbian, the evidence furnished by these fortunate finds compels us to conclude that the people who made these polished celts and axes, who carved these pipes, who made or at least used these copper implements, and engraved these shells with the figure of the mystic serpent, so strongly reminding us of Central-American figures, also had in possession these iron implements, and were mound-builders. That this burial-pit was made by the same people who erected the mounds of this region cannot be doubted.

CYRUS THOMAS.

PENNSYLVANIA ANTHRACITE.

SOME of the commonest articles used, either for manufacturing purposes or in the household, are frequently those about which we have the least definite information as to their composition or value. Near the point of production or manufacture, the consumer is apt to exhibit the most discriminating judgment in the selection of special brands or grades, on account of closer competition and a greater variety from which to make a selection. This is frequently done on the basis of a personal estimate, without substantial facts to warrant it. To no natural product does this apply with greater force, at the present time, than to the Pennsylvania anthracites, which are now depended upon by manufacturers and housekeepers, either as a necessary or luxuriant fuel, throughout portions of the entire western continent, and are used at points as distant as China and Japan.

Both the manufacturing and domestic consumers are beginning to realize the fact that their coal purchased this year does not seem

to burn so freely, does not fire with so little trouble, and does not last so long, as that purchased during the last and previous years, or *vice versa*. Where coals of different sizes, or from different districts, are offered to the trade by the same or competing salesmen, the question suggests itself, what shall we buy?

Among housekeepers, who are the smallest and most numerous class of consumers, distinction is seldom recognized between these anthracites. By other consumers the coals are grouped into those, which, when burned, will produce either a white or a red ash, special qualities being arbitrarily attached to each. Others, again, know only of three varieties: 1°, those from the Wyoming and Lackawanna fields, or the coals shipped from the northernmost basins over the railroads running through north-eastern Pennsylvania direct to New York (notably, the Delaware, Lackawanna, and Western, Delaware and Hudson, and Erie railways); 2°, those shipped by the Lehigh valley railroad, and the Central railroad of New Jersey, down the Lehigh valley; and, 3°, those over the Philadelphia and Reading railroad down the Schuylkill valley. Still other distinctions are arbitrarily made, which it is not necessary to note. In special localities, where a favorite coal is largely used, the consumer will speak of one class, that composed of his favorite coal, which possibly comes from two or three collieries, with a total aggregate annual production of less than a million tons; and of a second class, that composed of the coals from all other collieries, represented by an annual production of over thirty million tons. I have noticed this particularly in sections of New England, where even an intelligent consumer will sometimes speak of Lykens valley coal and of all other Pennsylvania anthracites.

The pressing demand which has been made upon the Geological survey of Pennsylvania, for some answer as to the fuel-value of different coals, has led me to consider what is the composition of Pennsylvania anthracite, as a preliminary step in the investigation.

Various percentages of fixed carbon have been assigned by different authorities to a typical anthracite. That which has been most generally accepted has been about 94, with all the accidental impurities, such as those which are generally classified under ash and sulphur, eliminated. Professor Rogers (Final report of first survey, vol. ii. pp. 969, 970) gives analyses of fifteen specimens of hard, dry Pennsylvania anthracite, which show an average, of fixed carbon, 88.05; of volatile matter, 5.81; of

ash, 6.14. Eliminating the ash from these analyses, the percentages of the constituents of fuel are as follows: fixed carbon, 93.8; and volatile matter, 6.2. This result is identical with the composition assigned by Newberry to a typical anthracite (Johnson's cyclopaedia, vol. i. p. 993).

The range of fixed carbon in the analyses of these fifteen specimens was from 94 to 80; the specimen showing the maximum being obtained from near Pottsville, and that showing the minimum from near Pine Grove, both from the Southern field in Schuylkill county. The range in volatile matter in the fifteen analyses is from 1.40 to 9.53; the minimum amount being in the same Pottsville specimen, and the maximum in a specimen from Black Spring Gap. The range in ash was from 2.90 in a specimen from Tamaqua, to 12.28 in a Pine Grove specimen. These results are certainly misleading; for it has been a long-recognized fact, that the coals obtained in the Southern field do not contain the highest percentages of fixed carbon.

Taylor (Statistics of coal, 2d ed. p. 609) gives analyses of a number of Pennsylvania anthracites reported from various sources. Twelve specimens from the Panther-Creek basin, between Mauch Chunk and Tamaqua, showed the following:—

	Averages.	Maximum.	Minimum.
Carbon	89.21	92.60	86.00
Volatile matter	6.38	5.00	4.54
Ash	4.41	7.00	1.28

Six specimens from the Lehigh region gave—

	Averages.	Maximum.	Minimum.
Fixed carbon	89.00	92.30	85.34
Volatile matter	7.05	9.60	5.36
Ash	3.93	8.73	1.28

All of these analyses, particularly those given by Taylor, are constantly quoted in numerous descriptions of Pennsylvania anthracite found in technical publications, both at home and abroad. The foreign books and journals have been reporting the higher results; so that the opinion prevails, that the hard, dry anthracite mined in the state will range from 90 % to 94 % of fixed carbon in the market product. Such is, however, not the case, as recent analyses¹ made by the Geological survey show.

¹ Andrew S. McCreath, analyst.

The results which have been reported in the Rogers and Taylor tables referred to may be taken as those of analyses of mineralogical specimens, which were in most cases carefully selected, either from the mined coal or from special portions of the bed. In no case, as I believe, are the analyses a guaranty of the character of the coal which was being mined or shipped as fuel from the individual localities at the time that the samples were collected. Even the specimens which were collected in considerable quantity, and analyzed and tested for their evaporative capacity by Johnson for the government in 1842 were not, I consider, fair averages of the coal which could be commanded in the market from the different mines for which his results were reported.

As indications of the composition of mineralogical specimens, the chemical analyses reported by Rogers and Johnson are of little scientific value, without a minute description of the physical characteristics and geological associations of the coal for which they stand. This conclusion could be substantiated by a number of instances to which I might refer; notably, one where I requested an experienced mining-expert to collect duplicate specimens from a point in one of the Mammoth bed mines, which, when analyzed, showed, much to my surprise, the following results:—

	Water.	Volatile matter.	Fixed carbon.	Sulphur.	Ash.
1	2.590	3.883	86.233	0.851	6.443
2	2.440	3.998	80.301	0.649	12.612

These two analyses are worthless as indications of the fuel-value of the coal, because it would be unreasonable to suppose that either one or the other specimen, showing such a wide range of composition, could be taken as a fair average of the coal shipped from this mine. Nor are they of scientific value, without certain facts, connected with the occurrence of the coal at this special point, to suggest some reason why such wide differences should exist.

If the amount of combustible matter in a coal is any criterion of its fuel-value, an examination which has recently been made by the survey shows how ignorant we are as to the actual worth of the different coals which we burn, and how readily we may be deceived by the special characteristics of a coal which we may have noticed, and by which we may have judged of its heating-capacity.

In order to test the value to be attached to

the judgment of the trade in discriminating between different coals, I requested one of the largest miners and shippers of anthracite coal, who has for a great many years been connected with the mines over a wide area in the region, to name a number of coals, which, by most consumers, were credited with being of about equal value. Specimens of these coals were collected from one or two hundred tons, as they were ready to be shipped to market; the amount collected for each analysis, ranging in weight from one to two hundred pounds, which was then reduced by the ordinary methods now commonly used in sampling any mineral product for qualitative and quantitative tests. The number of specimens obtained in this way aggregated thirty-three. The analysis of each individual specimen is recorded in detail on p. xlv. of my 'First report of the progress of the anthracite survey,' issued by the state printer on the first of this month. For our present purpose it is not important to refer to the results in detail.

The table of averages which I have compiled shows the mean character of the coal obtained from the more important coal-beds in the Northern field in the vicinity of Wilkes Barre, in the Eastern middle (Lehigh) field in the vicinity of Hazleton, in the Western middle field in the vicinity of Shenandoah, and in the Southern field on the property of the Lehigh coal and navigation company, between Mauch Chunk and Tamaqua. These results are shown in the following table:—

average of the two Primrose coals indicating 1.29%, and the average of the seven Mammoth specimens 5.4%, less fixed carbon than Taylor's average; the minimum fixed carbon in the survey's analyses being 78 as against 86 in Taylor's table, and the survey's maximum being 88 against 92.6.

These results evidently prove, 1°, that the specimens which were collected in the past for analysis were not sampled with sufficient care; for with the improvements which have been made in breaker machinery, and the greater care exercised in the preparation of coal for market, we might reasonably expect to find the higher percentages in the more recent analyses: and, 2°, the necessity of changing the basis upon which Pennsylvania anthracite has been rated in the past.

CHARLES A. ASHBURNER.

IMPROVEMENTS IN TESTING-MACHINES.

SOME philosopher has remarked that the prosperity of a nation is directly in proportion to the success of its people as constructors. According to this maxim, America occupies a very high place in the list of nations. With our almost inexhaustible ore-beds, and fertility in inventing new processes of mining and working metal, the necessity of becoming better acquainted with the properties of American building-materials is daily growing more apparent; and at present no question is exciting

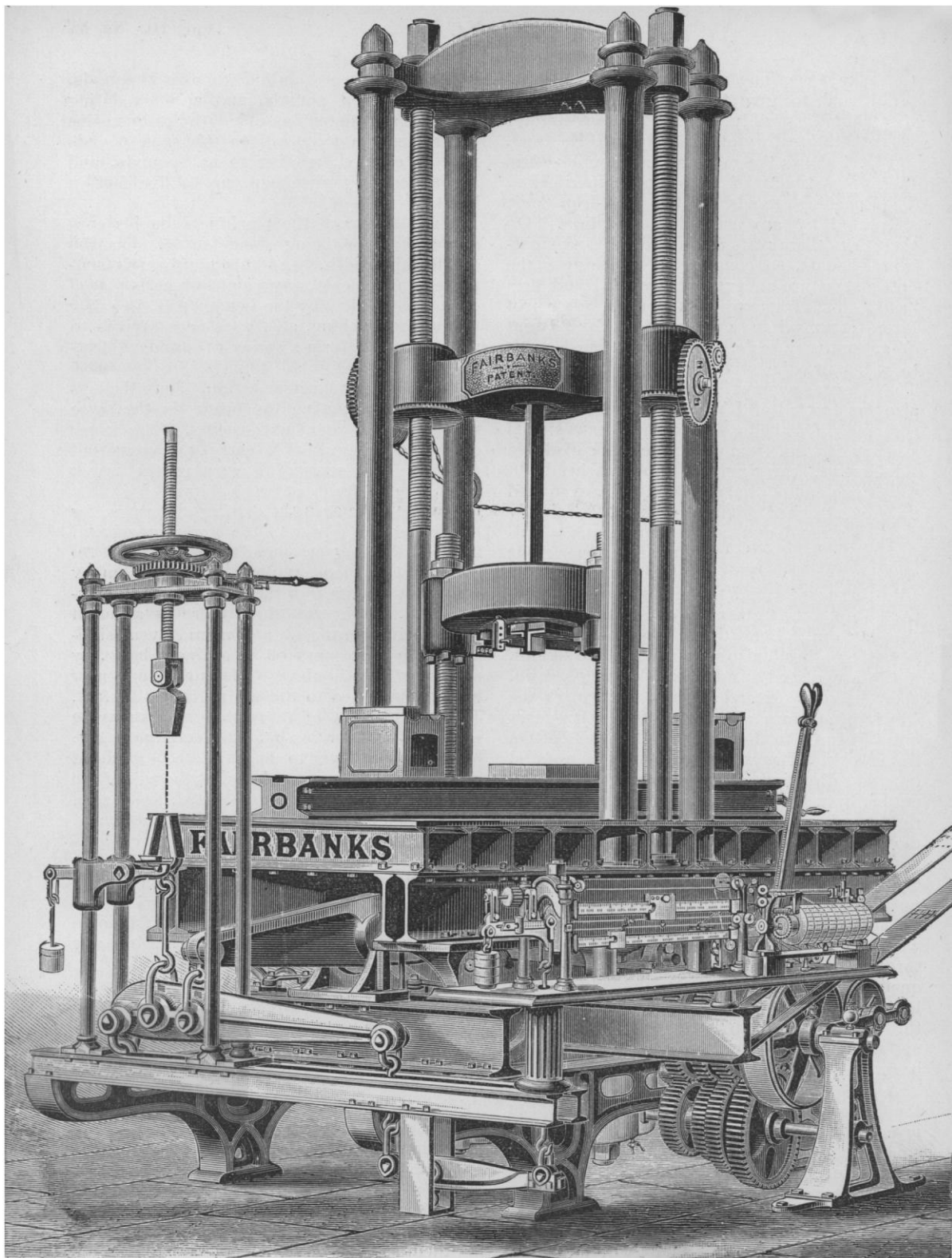
No. of specimens.	NAME OF COAL-BED.	NAME OF COAL-FIELD.	CHEMICAL ANALYSIS.						Specific gravity.	PERCENTAGE OF CONSTITUENTS OF FUEL.			
			Water.	Volatile matter.	Fixed carbon.	Sulphur.	Ash.	Total.		Fixed carbon.	Volatile combustible matter.	Fuel ratio, C.	V. H. - C.
3	Wharton . . .	Eastern middle . .	3.713	3.080	86.404	.585	6.218	100	1.620	96.56	3.44	28.07	
5	Mammoth . . .	Eastern middle . .	4.119	3.084	86.379	.496	5.922	100	1.617	96.55	3.45	27.99	
2	Primrose . . .	Western middle . .	3.541	3.716	81.590	.499	10.654	100	1.654	95.64	4.36	21.93	
5	Mammoth . . .	Western middle . .	3.163	3.717	81.143	.899	11.078	100	1.657	95.62	4.38	21.83	
2	Primrose? (F) .	Southern	3.008	4.125	87.982	.506	4.379	100	1.584	95.52	4.48	21.32	
2	Buck Mountain .	Western middle . .	3.042	3.949	82.662	.462	9.885	100	1.667	95.44	4.56	20.93	
1	Seven-foot . . .	Western middle . .	3.410	3.978	80.868	.512	11.232	100	1.651	95.31	4.69	20.32	
7	Mammoth . . .	Southern	3.087	4.275	83.813	.641	8.184	100	1.631	95.15	4.85	19.62	
3	Mammoth . . .	Northern	3.421	4.381	83.268	.727	8.203	100	1.575	95.00	5.00	19.00	

These analyses are arranged in the order of the percentage of fixed carbon in the fuel constituents.

A comparison of these results with those already referred to, as given by Taylor for the Panther-Creek basin, shows wide differences. The two Primrose and seven Mammoth specimens reported in the table for the Southern field came from the Panther-Creek basin; the

more attention among our constructors than that of the strength of materials.

About two years ago Messrs. Fairbanks & Co. conceived the idea of locating in New York a bureau so arranged that engineers and all interested could be afforded an opportunity



to make experiments and tests on any material, and to give to America a laboratory that should speedily become to our country what the laboratory of Kirkaldy is to England.

Fig. 1 shows the machine now employed in their department of tests and experiments. The machine stands on two cast-iron legs, supported by any suitable foundation. On these legs there rests a framework of wrought-iron I-beams, so constructed as to give the entire structure an exceedingly solid and firm basis. This framework supports a system of levers arranged in a manner similar to that of an ordinary scale, only proportioned so as to withstand the severe stresses and shocks. These levers support a secondary framework, also constructed of I-beams, and carrying four columns. On the tops of these columns stands a heavy casting, from which are suspended two side-screws, carrying the top crosshead, to which one end of the specimen to be examined may be attached. These screws are simply used as a rapid and convenient means of adjustability, so that longer or shorter specimens can be tested. This system — namely, the adjusting-screws and top crosshead — is supported upon the framework of I-beams forming the platform. Beneath the top crosshead is a second crosshead, also supported on two screws, which are placed inside the adjusting-screws. These screws extend downward through the platform, and are attached to two worm-gears firmly secured to the under side of the bottom framework. The worm-gears may be rotated in either direction, at the pleasure of the operator, by means of the belt and gears at the right hand. The worm-gears and screws form the straining-mechanism, capable of applying any stress up to two hundred thousand pounds. Great care is taken in the construction, so that no part of this mechanism whatsoever shall touch, or in any other way come in contact with, the platform, save solely and simply through the specimen to be tested: consequently all the stress produced by the crosshead on the platform must necessarily pass through the specimen; and only this amount, and no more, can be estimated on the weighing-beam.

A part of the scale system may be seen in the front of the cut; the end of one of the large levers extending under the platform, and two smaller ones carrying the stress from the end of this lever to the beam. Over the larger one of these levers are four small columns supporting a handle and lever. This apparatus is a testing-machine in miniature. The full power of the machine may be used, having a

capacity of two hundred thousand pounds, reading to ten pounds, and accommodating specimens up to ten feet in length; or by means of the lever a force of ten thousand pounds may be exerted, reading to half-pounds, and accommodating specimens up to five feet in length.

The platform of the machine occupies considerable space, being some ten feet long by six feet in width. As this platform is supported on the scale, any weight which is placed on it must be felt by the beam; and, in order to test the machine, all that is necessary is to pile on the platform a series of standard test-weights.

Fig. 2 is a transverse section. Here the legs are shown supporting the beams in the same way as in the previous drawing. The lower crosshead screws, *k k*, carry the crosshead *C*, while the screws *h*, carrying the upper head, are in front of the columns *j j*. At the left may be seen the driving-apparatus for furnishing the power to the lower crosshead, the belt *l*³ being arranged to slide to and fro on a tight and loose pulley. The tight pulley conveys the motion of the belt to the top driving-shaft. On this shaft there is a set of three gears, arranged in a manner very similar to the back gears of an ordinary lathe, by means of which three different speeds may be communicated to the main driving-shaft, *l*. Just to the right of these three gears may be seen a set of reversing-gears, so arranged, that, by throwing a lever to and fro, the crosshead may be run either up or down, at the will of the operator. On the driving-shaft, *l*, are placed two worms, cut, respectively, right-handed and left-handed. These match in the corresponding worm-gears which are placed at the bottom of the screws *k* and *k*. The main screws are cut right and left handed, so as to turn in opposite directions, neutralizing all the frictional stresses of the crosshead, and preventing any tendency to twist.

Perhaps the action of the machine can be well understood by supposing a test-piece in tension. The piece is secured in the top crosshead, *B*, by wedges; the other end, secured to the lower crosshead, *C*, thereby forming the only connection between the platform and the driving-mechanism. As fast as the screws are turned, stress is exerted on the specimen, which is communicated to the platform, and weighed by means of the beam at the left hand.

The results of tests are so largely dependent upon the skill of the operator, that very naturally much hesitation has been felt in accepting them as conclusive. It has been the aim,

in the design of the present machine, that as far as possible the machine should do its own work, thereby eliminating from the result all personal equation; and, supposing the machine

of the machine coincide with the axis of the specimen. In making experiments on wrought iron and steel, and upon other materials which are more or less of a ductile character, this

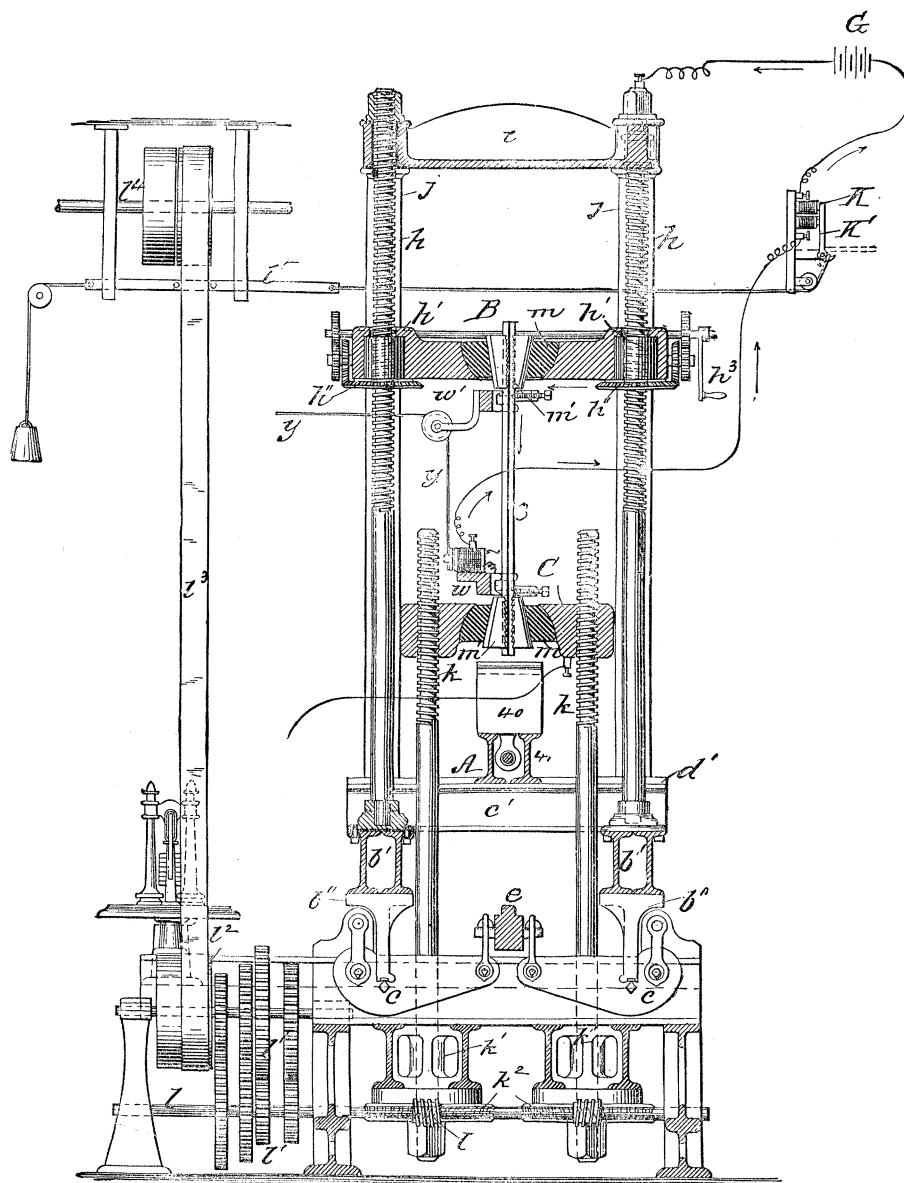


FIG. 2.

to be once correct, all subsequent records should be correct mechanically. One of the greatest obstacles to making accurate tests has been the feasibility of making the axis of stress

objection is not a serious one, as it introduces but a slight error in the results. In experiments on cast-iron, cast-steel, or materials of a brittle character, the slightest cross-strain

vitiates the results, introducing stresses into the test-piece which produce an effect not to be calculated upon.

By referring to fig. 2, a device for enabling the machine to automatically centre the test-piece may be understood. The top and the bottom crossheads have in their centres a large spherical concavity. This concavity contains a segment of a sphere in which the wedges for gripping the test-piece are placed. The spherical segment is made of steel turned and polished, and the concavity is lined with the best anti-friction metal. Any eccentric stress swings the segments in their sockets, and causes the axis of stress in the machine to coincide with the axis of the test-piece. The spherical segments weigh about two hundred pounds. They are, however, carefully supported on India-rubber springs, so as to eliminate as far as possible the weight of the segment from the friction in its socket. But supposing, under the most unfavorable circumstances, the whole weight of the segment does come on the joint, the coefficient of friction is not over two per cent: consequently a maximum cross-strain of four pounds on the test-piece will cause the segment to swing, and to adjust itself to the axis of stress through the piece. As this weight of four pounds is less than half the least reading of the poise, it may be assumed to produce no sensible effect on the piece to be examined.

The most of the testing-machines now in use require a careful preparation of the test-piece previous to an examination. If, for example, it is wished to ascertain the strength of an I-beam or of a channel, it is necessary to send the shape to the machine-shop, and plane a piece of one or two inches in area. This requires much time and expense. The specimen is then sent to the testing-machine and broken; and what is obtained? Simply the result of a piece cut from the shape, which may or may not give a fair knowledge of the actual strength of the member in question. What is wanted at the present time is not the strength of a carefully prepared test-piece, broken under special circumstances, but of the actual bar just as it comes from the rolls in the mill itself. The spherical segments in the crossheads of the Fairbanks testing-machine have four sides inclined at an angle of about twelve degrees to the axis of the machine. Two of these sides are curved, and two are straight. By using a number of wedges with backs correspondingly curved or straight, any piece, of whatsoever section, may be completely surrounded by the wedges, and gripped on all sides; so that a channel, an angle, and I-beam, a T or a star,

or, indeed, any of the shapes now rolled in the mills, may be placed in the machine and broken in full size.

Much time and labor have been spent to accomplish the power of autographically recording, at each instant of time during the experiment, the amount of stress, and the effect produced thereby on the specimen. To the best of the author's knowledge, Professor Thurston of the Stevens institute was the first to originate the idea of making a testing-machine in such a manner as to record graphically. In 1876, at the Centennial exhibition, Professor Thurston exhibited a machine designed to make tests in torsion and to record the action thereof. As a matter of history, it may be stated, that, while engaged in examining material for the East River bridge in 1877, the author designed and built the first testing-machine to autographically record results of the experiments in other stresses than that of torsion. While this machine, being the first of its kind, was necessarily crude and imperfect, it gave for some years very satisfactory results, and is still in use by the Bridge company. While the present machine is essentially different from the one just mentioned, the principles employed are the same as those devised for the East River bridge.

Referring to fig. 2, it will be seen that the battery *G* is attached to the top of the adjusting-screws *hh*. These screws are carefully insulated from the rest of the machine. As soon as the test-piece is placed in the top crosshead, it becomes thereby connected with the battery. On the lower end of the specimen may be seen a small clamp, carrying an electromagnet. One end of the wire of this magnet is in connection with the specimen, while the other end of the wire is joined to a little binding-screw on top, to which the other pole of the battery is attached; so that the current actuating this magnet flows through the test-piece under examination. It will also be seen that the magnetic clutch, *m*, for holding the driving-belt on the tight pulley, is also included in this part of the battery-circuit. When the rupture of the test-piece occurs, the current is broken, the magnetic clutch is released, the belt slides by means of the counterpoise weight to the loose pulley, and the testing-machine stops. On the top of the specimen nearest to the upper crosshead is attached a second clamp, carrying a small sheave or pulley. Around this pulley, parallel to the specimen, and attached to the armature of the lower clamp magnet, passes a flexible steel tape, *y*, that, after passing alongside the specimen, runs

down to a pencil or stylographic pen that is carried on a sliding-track placed over a metal cylinder carrying a sheet of cross-section paper. It is obvious, that, as fast as the specimen elongates under the action of the stress, the pencil is drawn along the ways of the cylinder parallel to its axis.

Figs. 3 and 4 show the beam and registering-cylinder. In fig. 3 it will be seen that the beam consists of a single bar, sustained on a stand at one end, and enclosed in a guard at the other, while on this beam there rests a semicircular brass box forming a poise. Along the top of the beam, there is cut an exceedingly fine rack; and the motion of the poise is ob-

the motion of the poise with the motion of the cylinder exactly, so that, in a given travel of the poise along the beam, the cylinder may move a corresponding quantity. Of course, the ratio between the two movements is simply a matter of proportioning so as to accommodate the ordinary cross-section sheet to the circumference of the cylinder; but an exact and constant ratio is a very important point. Inside of the poise are two large wheels, about eight inches in diameter. The wheel placed in front is graduated with a series of numbers. The pinion carrying the poise along the beam is an inch in circumference, and consequently a single revolution of the pinion carries the poise

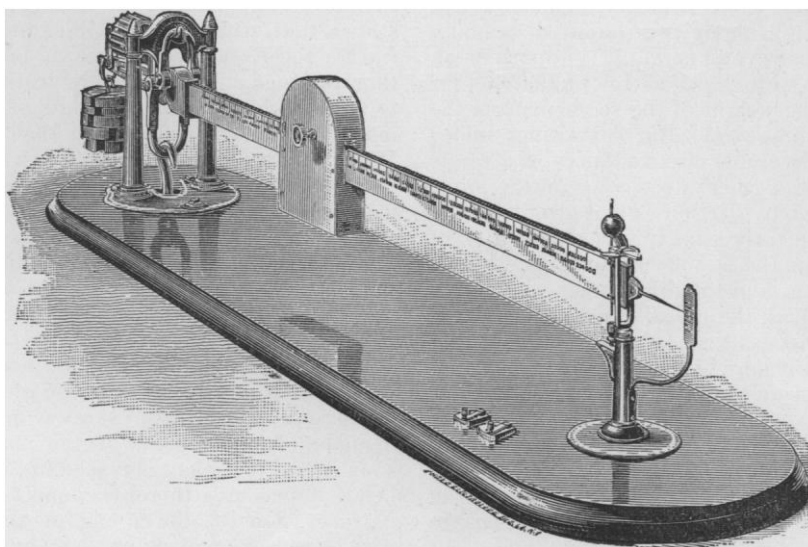


FIG. 3.

tained by a pinion placed inside of the box and gearing into this rack. At the end of the beam may be seen the mercury-cups for making an electrical connection as the beam rises and falls. The operation of this piece of apparatus is substantially as follows. The clock-work motor contained in the poise, for driving it to and fro on the beam, is connected with the mercury-cups by means of some brass strips placed in the rear of the beam. These strips are connected with two electro-magnets on the inside of the poise: consequently, when the beam either rises or falls, one or the other of the magnets is excited, the corresponding train of clock-work is thrown into action, and the poise rolls to and fro until a balance is re-established. This motion of the poise to and fro on the beam is exceedingly simple, the knotty part of the problem being to correlate

one inch along the beam. The front wheel is secured directly to the pinion-shaft, so that there can be no back-lash between the two; and, being eight inches in diameter, one revolution of the pinion causes this dial-wheel to travel twenty-five inches of circumference. A motion of one inch along the beam corresponds to a weight of four thousand pounds. The dial-wheel being eight inches in diameter, and subdivided into four hundred parts, each of these parts corresponds to ten thousand pounds. The rear wheel of the poise is constructed in precisely the same manner as the front wheel, excepting that the marks on the dial are replaced by little strips of India-rubber, so that the wheel presents a series of teeth alternately made of India-rubber and of brass. On this wheel, there presses a brass commutator-strip, so arranged as to include the cylinder in its

electric circuit. As soon as the poise commences to move along the beam, this wheel, with its insulated spaces, commences to turn under its commutator-strip; and with every passage of a tooth under the strip a current passes into the cylinder. Inside of the cylinder are two toothed wheels, mounted on the central shaft, and capable of being ratcheted round by means of a little lever arm and pawl, operated by a magnet placed directly under each of the wheels.

locked up in a way to be absolutely exterior to any control on the part of the operator.

An old proverb has said that 'the proof of the pudding is in the eating.' In fig. 5 may be seen a half-dozen curves corresponding to as many test-pieces. The vertical scale gives the stresses, while the horizontal scale gives the normal stretches, of the pieces under examination. The two steel curves bear to each other a strong resemblance. Each commences

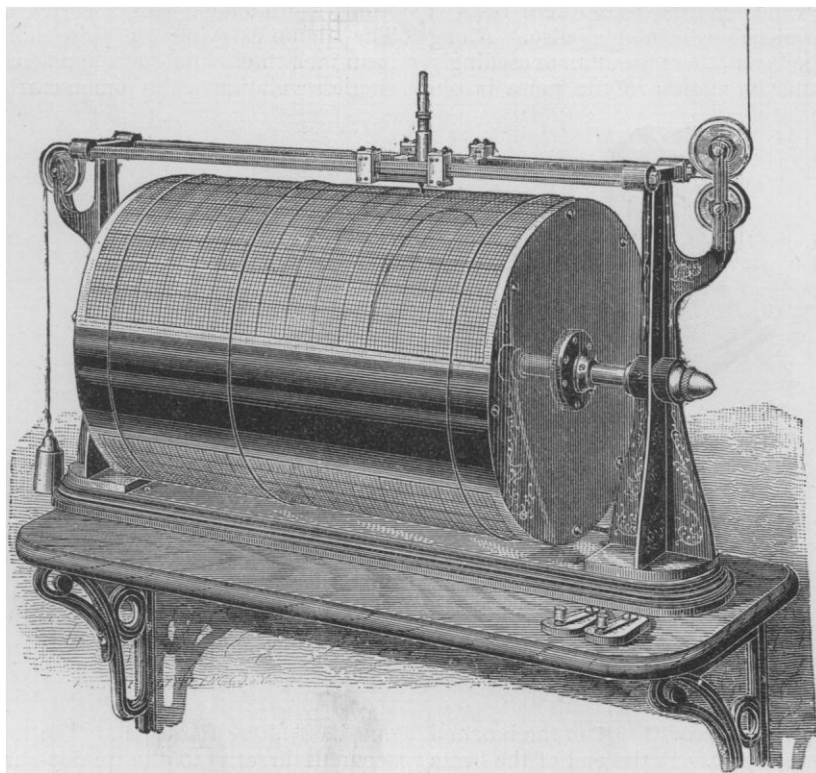


FIG. 4.

One of these wheels is intended to drive the cylinder in one direction, and the other in a contrary. One electro-magnet is connected with the mercury on the bottom of the beam, and the other in the mercury-cup on the top. As a consequence, as soon as the beam makes connection with either cup, the poise commences to travel: the corresponding electro-magnet acts, and rotates the cylinder in one way or the other. The cylinder might be placed in New York, and the registering-cylinder in Cincinnati, and the two work absolutely in harmony with each other: so, should it ever be deemed expedient, the cylinder may be enclosed or

with a line slightly inclined to the axis of stress at a constant tangent. As soon as the elastic limit is reached, a sudden point of inflection occurs. Very soon, however, there is a second point of inflection, and the curve takes on a parabolic form. The steel curves, as well as that given by the specimen of Ulster iron, may be taken to be typical forms obtained from the material which is nearly homogeneous. The lines are quite true, and without any special irregularities, until the maximum stress is reached, shortly before the specimen breaks. The stress then commences to decrease, owing to the rapid reduction of area of the piece;

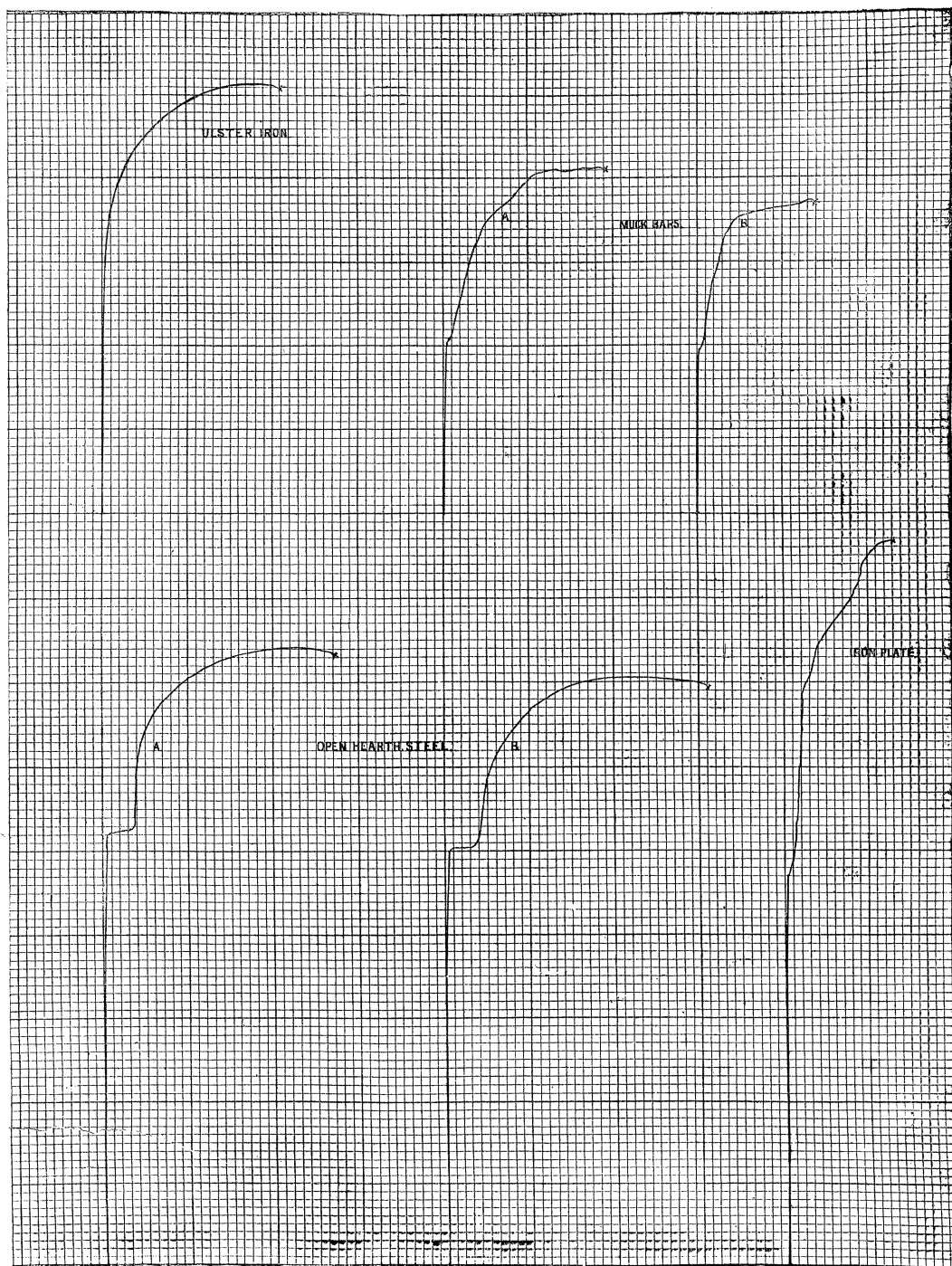


FIG. 5.—AUTOGRAPHIC RECORD ON FAIRBANKS TESTING-MACHINE.
Vertical scale, 10,000 lbs. to the inch; horizontal scale, normal stretch.

and with the reduction of the stress, the curve drops, until very shortly the specimen is ruptured, and the apparatus comes to a standstill. The other three curves are those given by a piece of boiler-plate and of a specimen of muck-bar, and are very good examples of the value of the autographic method. As is well known, both boiler-plate and muck-bar are decidedly non-homogeneous; and as a result we have curves here that are exceedingly irregular, especially after passing the elastic limit. While they bear a general resemblance to the previous ones, they are full of points of inflection, turning and twisting about, and giving one an idea that the specimen consisted of a bundle of threads or fibres which gradually parted under the action of the stress, giving any thing but a constant and uniform action.

In conclusion, a word as to the practical accuracy of the lever testing-machine may not be out of place. The machine under consideration has been subjected to severe use for nearly two years, during which time its sensitiveness, even when loaded, has not risen so high as the least reading on the poise. From this, and from long practice in similar scale-work, it may be safely stated that the testing-machine, with proper care, may have an exceedingly long life. The attainment of absolute accuracy in any department of investigation, would, if it were possible, be an extremely desirable result; yet even our best experiments are simply close approximations to the truth, and it will be granted that it is desirable to make all of our improvements commensurate towards an absolute standard of accuracy. It is of no importance to carry the weighing-power of the testing-machine beyond the possibility of the measurement of the bar. For example: supposing the tests most frequently made are those of bars having about a square inch of cross-section. In a piece of iron an error of a thousandth of a square inch of cross-section corresponds to a possible inaccuracy, in the stress produced on the bar, of fifty pounds; while the corresponding quantity in a steel bar corresponds to about seventy to ninety pounds. There are very few lathes in the country in which it is possible to turn a bar so exactly that it shall be perfectly round, and that there shall be no variation from one end to the other of more than a thousandth of a square inch. There are few men that are capable of manipulating any lathe to produce such a result; and there are still fewer gauges that are capable of measuring even a perfect bar so as to exclude the possibility of an error as great as a thousandth of a square inch. Now, if it be impossible to

measure our bars to within an error of fifty to a hundred pounds in the testing-machine, is it of any importance to refine the machine beyond this reading? In the lever system of testing-machines it is perfectly possible to obtain a machine which will uniformly and constantly give readings which shall not have a greater variation than from five to twenty pounds; and, if our bars can only be measured to fifty or a hundred pounds, would it not be wiser to spend money in refining the gauges rather than in refining the machine? Again: when the consideration of the tests on the full-sized members occurs, or bars direct from the rolls, carrying with them the scale, and other imperfections from the mill, the possibility of measuring to a thousandth of a square inch becomes absurd, and two or three hundredths is the nearest approximation that can be made. In making a test of an ordinary I-bar, of, say, five or six inches of cross-section, it is certain that the bar has any thing but an absolutely uniform section from end to end; and how long, may it be asked, would it take to measure that bar from end to end, so that the least cross-section could be obtained for the record? And again: in actual experience it has been frequently found, that, having obtained what is supposed to be the least cross-section, the test-piece may break in a totally different place. It will be conceded that practical engineers care very little for test-records beyond the hundredth's place of figures; and what the country wants at the present time, is not so much testing-machines constructed with a theoretical refinement of accuracy, as a large number of practical machines, so that one may be located in every iron-works in the country, and means to carry on the experiments and to obtain from these machines a practical knowledge of what America's constructive materials really are.

A. V. ABBOTT.

NEW METHOD OF MOUNTING REFLECTORS.¹

It is well known to all who have given attention to this subject, that the optical performance of great reflecting-telescopes has not been proportional to their size, and that the mechanical difficulties of keeping a large reflector in proper figure in different positions have been apparently insurmountable. A plan of supporting a large mirror, devised by Mr. Henry, has been adopted in Paris, which it is hoped may obviate this difficulty. It consists, in principle, in supporting the mirror upon a

¹ Extracted from a report to the secretary of the navy on improvements in astronomical instruments.

second surface, ground to fit it with accuracy when the mirror is in proper shape. If the mirror rested directly in contact with this second surface, no advantage would be gained, since the backing itself would bend as readily as the mirror. Therefore between the two is inserted a thin stratum of some elastic substance. Mr. Henry has found a fine sheet of flannel to give the best results. The effect of the sheet is to diminish the flexure of the mirror by a fraction depending on its stiffness and on the elasticity of the flannel. Theoretically it may be considered imperfect, because, in order to act, some stiffness is required in the mirror itself. A perfectly flexible mirror would bend just as much with the flannel as without it. But the flexure of the mirror can, it appears to me, be reduced to quite a small fraction of its amount. Moreover, I see no insuperable objection to the superposition of two systems of the kind; the mirror resting upon a stiff disk, which is itself supported upon a second one. This plan has been entirely successful in the cases in which it has been applied. Mirrors up to twelve inches in length show not the slightest flexure when moved into all practical positions. Unfortunately it has not yet been tried with reflectors of a larger size.

SIMON NEWCOMB.

AFTER-IMAGES.

THAT one cannot well contribute to a subject unless he knows something of its literature is illustrated afresh in a painstaking article by Mr. Sydney Hodges, in the October number of the *Nineteenth century*, on 'After-images.' Mr. Hodges has discovered for himself the fact that the after-images of bright objects are in general colored, and that they change color as they gradually fade away in the dark field of vision when the eyes have been covered. He has very carefully observed the phenomena in his own case; and he comes to the conclusion, that, in all cases of such after-images, "the color of the image is produced, not by the tint of the object we look at, but by the amount of light thrown on the retina, either by the greater or less intensity of light in the object itself, or by the amount of time during which one looks at it." This remarkable result is, however, reached by experiments that cannot prove it: for in all of them the conditions are too complex; namely, in all the important cases, our experimenter observed the bright object for a comparatively long time before covering the eyes. The common theory of these phenomena, however, assumes, that, after such a continued observation, the causes of the colors in the after-image are decidedly complex; and their complexity may be such as to render a complete explanation of the phenomena wholly impossible. Therefore the only simple way to begin observing

the phenomena is to get instantaneously produced after-images, and to observe the order of colors in them as they disappear: for the common theory is substantially, that the separate nervous elements, whatever they are, that respond to the different wavelengths, or that produce, when excited, the three primary color-sensations, recover from the after-effects of excitement with different degrees of rapidity, and again, if continuously excited, yield to exhaustion with various degrees of speed; so that the color of the after-image at each instant, since it must depend on the mixture of the different after-effects in the different elements, must vary as these elements return, each at its own rate, to the condition of rest, and must so depend, not only on the rates of recovery of each element, but also upon the degree of exhaustion that each element has undergone during the time of stimulus. Hence the simplest case would be the one where the degree of previous excitement was as nearly as possible equal for the different elements, — a case which would be realized best through momentary stimulus. But if the stimulus is continued ten or twenty seconds, then the after-image will be further affected by the rates at which the different elements have tended to get exhausted; and if these rates are themselves quite different, as is likely, then the after-image will be determined in its successive colors, not only by the different rates of subsidence of excitement in the elements, but by the different degrees of previous exhaustion: and all this may possibly so complicate things as to make the phenomena of the after-image seem wholly out of relation to the color of the original object. And thus any such uniformity as our author notices will be of little worth, unless we know just the conditions of time and illumination, and unless we observe the results with very many persons; and even then the facts may turn out to be too complex for us to explain, so that no light will be thrown by them on the theory of after-images.

All this Mr. Hodges could have found stated or implied in many places. The phenomena have been much observed and discussed. Helmholtz gives the older literature in § 23 of his *Physiological optics*, and himself declares that it is impossible, by reason of the complexity of the phenomena of fatigue, to give a complete explanation of these phases. Wundt, in the *Physiologische psychologie*, while not agreeing as to the theory with Helmholtz, still holds to an explanation somewhat analogous; and he considers, that, to avoid confusion, one must clearly separate the cases of instantaneous stimulation from the more complex ones, in which, as he implies, fatigue and other causes may affect the phenomena (*Op. cit.*, bd. i., p. 438, of 2d ed.). But of such separation our author is ignorant, and confuses all the phenomena in one mass together; so that observations that might easily have been made really valuable for the theory cannot well be used in their present shape at all, and can only raise in the casual reader's mind a false hope that a law has been found, when, in fact, as it is stated, the supposed law of our author is false, and is at once contradicted by the observation,

added by himself in a footnote, that the "solar spectrum does produce the complementary colors in the after-image." For if the so confidently proclaimed law did not turn out true for saturated colors, the simplest of all perceptions of color, why did not our author suspect that he was on dangerous ground? As for the rest of his article, it is really no contribution to science, but contains an effort to refute the doctrine of fatigue in favor of some quite unintelligible explanation of after-pictures, and to edify the reader by general reflections.

We are far from being fully persuaded of the truth of the common theory, and have nothing ourselves to add to the discussion of the subject, save the present note of warning to solitary observers of mental phenomena. Let us all observe, by all means, and independently; but let us know what other people have said, or at least what the greatest men have said. Mr. Hodges is actually capable of believing and saying, at the outset of his article, such words as these: "I should add, that brief references to after-images with closed eyes may be found in Helmholtz's great work on Physiological optics, in Dr. Foster's Text-book of physiology, and in a few other works; but the fact that neither of them contains any detailed experiments (?) such as I am about to describe, induces me to hope," etc. And this Mr. Hodges could write, presumably with Helmholtz's book, § 23 and all, before him. What he is about to describe we have indicated. He looked at a window, and then covered his eyes; afterwards he tried the sun, colored cards, etc.; then he asked two or three people to try similar experiments; and then he wrote his article. And now who shall say that every intelligent man understands how to use even the best-known and best-arranged books? And why should the pages of the *Nineteenth century* be thus occupied?

JOSIAH ROYCE.

LAKES OF THE GREAT BASIN.

As the geological observations given in a recent paper by Prof. E. D. Cope¹ relate to a region somewhat familiar to me, I venture to offer the following comments.

Under the heading of 'Preliminary observations' it is stated that the geologists of the Fortieth-parallel survey have shown that Lake Bonneville existed during tertiary time. It must be known to every one, however, who has read vol. i. of the reports of the survey mentioned, that this lake is there classed as quaternary: it has been so regarded by all geologists who have made any considerable study of the surface geology of Utah. Lake Lahontan is supposed, with good reason, to have been contemporaneous with Lake Bonneville, and therefore also of quaternary age. Recent observations tend to prove that the last great rise of these lakes was later than the greatest extension of the Sierra-Nevada glaciers,

and perhaps synchronous with the Champlain epoch of the Atlantic coast.

Lake Bonneville was not named by the geologists of the Fortieth-parallel survey, as stated by Professor Cope, but was first so designated by Mr. Gilbert.¹

The list of lakes given as now existing in the Lahontan basin should also include Honey Lake, California, as the valley in which it occurs formed a bay of the old lake with over three hundred feet of water. A map, showing the outline of Lake Lahontan as recently determined, will appear in the third annual report of the U. S. geological survey.

The prediction "that it will be shown that a third lake existed in Oregon, north of the supposed northern boundary of Lake Lahontan," has proved correct only in part. A geological reconnaissance conducted by myself in this region in the spring of 1882 has shown that the Great Basin, north of the hydrographic rim of Lake Lahontan, was divided during quaternary time into not less than ten independent hydrographic areas, each of which held a lake of small size, as compared with Bonneville and Lahontan.

The statement that "the lakes of the Great Basin in Nevada and Oregon diminish in alkalinity as we approach the Sierra Nevada Mountains," meets with a notable exception in Moro Lake, California, which lies at the immediate base of the highest portion of the mountains, but is yet, according to an analysis of its water made for me by Dr. F. W. Taylor, far more alkaline than any of the lakes of the Lahontan basin, excepting the soda-ponds at Ragtown, Nev.

Professor Cope also says, that "the lakes most remote from the mountains are not inhabited by fish, their only animal population being crustacea and the larvae of insects." That this conclusion is too broad is illustrated by the life of Humboldt Lake, which is inhabited by both fish and mollusks, and also that of Ruby and Franklin lakes, situated still farther eastward, which abound in molluscan life. That the freshness of lakes, and consequently their inhabitability by fishes and mollusks, do not depend on their relation to mountains, or even on the existence of an outlet, can be shown by numerous examples in the Great Basin. The only explanation of the apparent anomaly of an enclosed lake of comparative freshness (with less than one per cent of saline matter in solution) in the nearly desiccated basin of a far larger lake, which never overflowed, has been suggested by Mr. Gilbert.² His hypothesis is, that such lakes owe their freshness to complete desiccation and the burial of the precipitated salts beneath plaza deposits. When water re-occupies such a basin, the imprisoned salts may not be redissolved. It is evident that this process might take place in any part of an arid region like the Great Basin, whether it be near or remote from mountain ranges.

The locality mentioned on p. 137 as having furnished fossil remains is included within the still distinct beach-lines of an ancient lake which once filled the Christmas Lake and Silver Lake valleys. The shells collected at this locality by myself have been

¹ On the fishes of the recent and pliocene lakes of the western part of the Great Basin, and of the Idaho pliocene lake (*Proc. acad. nat. sc. Philad.*, June, 1883).

¹ Wheeler survey, vol. iii. pp. 88, 89.

² Second ann. rep. of U. S. geol. surv., p. 177.

examined by Mr. R. Ellsworth Call, who reports the following species: *Aphaerium dentalum* Haldeman, *Pisidium ultramontanum* Prime, *Helisoma trivolvis* Say, *Granulus vermicularis* Gould, *Limnophysa bulimoides* Lea, *Carnifex Newberryi* Lea, *Valvata virens* Tryon.

The mingling of the blackened and mineralized bones of horses, camels, elephants, edentates, etc., with the shells enumerated above, presents a puzzling association of extinct tertiary(?) mammals with quantities of shells of living species, which we had hoped Professor Cope's studies would elucidate.

The presence of 'worked flints,' mingled with the fossil bones, is a matter of but little significance; as the bones occur on the surface, and might have had arrow-heads, etc., scattered among them at a very recent date. There is no evidence that the fossil animals, and the people who chipped the flints, were contemporaneous.

The valley of the Warner Lakes is referred to as a 'fractured anticlinal.' Again, the same expression is used in describing Silver Lake. We believe, however, that geologists familiar with the progress of exploration in the Far West during the past ten years would class these basins as monoclinal valleys, of the Great Basin type.¹ The Warner valley has a profound fault along both the eastern and western borders, and is enclosed to a great extent by lofty fault-scarps.

The Abert Lake basin also owes its formation to displacements. The lake occurs at the base of a great fault-scarp, forming a cliff two thousand feet high, and covers the depressed edge of a thrown block.

In the passage relating to Abert Lake (p. 138), the reader is left in doubt as to whether the lake, or the Chewaucan River, abounds in trout. Later, however, three species of fish are credited to Abert Lake. My own experience has been, that trout are abundant in the river, and absent from the lake; although they perhaps could exist in the latter in the immediate vicinity of the mouth of the Chewaucan River (frontiersmen who are familiar with the lake say that it is uninhabited by fish). During my own examination I found its waters swarming with 'brine shrimps' and the larvae of insects, but never saw a trace of piscine life. Its waters are strongly alkaline, and utterly unfit for culinary purposes. In its physical properties the water of Abert Lake resembles the brines of Sumner Lake (Oregon), Moro Lake (California), and the soda-ponds (near Ragtown, Nev.), all of which are too strongly alkaline to be inhabited by fishes. It is not evident on what authority Professor Cope ascribes a fish fauna to this lake, as on p. 138 it is stated distinctly that he did not get a near view of it.

From a study of the geographical distribution of the fishes in the lakes of the Great Basin, Professor Cope has found that the larger fishes inhabiting the lakes in northern Nevada and south-eastern Oregon are different from those of the lakes of the Bonneville basin. This is an interesting determination; as

the former basins were mostly without outlets during the quaternary, while the latter became tributary to the Columbia.

The effect of alkalinity on the growth of fishes has been noted by Professor Cope to some extent, and is evidently a study that might lead to interesting geological conclusions. The comparison of the faunas of Pyramid and Tahoe lakes would perhaps show the effect of salinity and alkalinity on the species of fishes which probably inhabit both lakes. Pyramid Lake, it will be remembered, is supplied almost wholly by the Truckee River, the outlet of Lake Tahoe.

Before concluding that "all the species of Pyramid Lake are peculiar to it, excepting *Catostomus tahoensis*," it would be desirable to compare its fishes with those of Walker Lake. As these two lakes are quite similar in chemical composition, and both occur in the Lahontan basin, it seems probable that their abundant faunas would be found nearly identical. One species of trout, at least, seems to the writer, from superficial examination, to be common to the two.

The second part of Professor Cope's paper is devoted to the description of the fossil fauna of 'Idaho Lake.' This lake existed in eastern Oregon and western and southern Idaho during pliocene time. No body of water represents it at present; and the fish-remains found in its sediments differ from those of the Oregon basin, both recent and fossil. The extent of this ancient lake is not known. Its sediments are named the 'Idaho formation,' but no typical exposure is described or in any way indicated. Even the locality at which the fossil bones were collected is, for some unstated reason, withheld. This method is to be regretted; as Professor Cope does not stand alone in making geological divisions on purely paleontological grounds, without attempting to describe or locate the formations named. If this practice is persisted in, it can only lead to confusion.

Of the twenty-two species of fossil fishes described, eight are new. Besides these, the sediments of the Idaho Lake have furnished three species of crawfish which were reported by Professor Cope some years since. The mollusks, it appears, have already been described by F. B. Meek. Both the vertebrate and invertebrate fossils of the formation determine it to be lacustrine and fresh.

Although we have ventured to take exception to a number of statements in the paper under review, yet we welcome it as adding materially to our knowledge in a field that had previously been but little studied.

ISRAEL C. RUSSELL.

Washington, D.C.

THE DEFINITION OF MEAN SOLAR TIME.¹

THE proper definition of mean solar time appears to me a very simple matter, and to have nothing arbitrary about it. The mean sun is merely an imaginary body which is supposed to move uniformly

¹ See 'Basin Range structure,' Geol. of the Uintah Mountains, Powell, p. 16.

¹ Paper by Prof. J. C. Adams of Cambridge, at the December meeting of the Royal astronomical society. From *The observatory*, February.

in the equator at such a rate that the difference between its right ascension at any time, and that of the true sun, consists entirely of periodic terms. This difference is called the equation of time, which, therefore, by its very nature, cannot contain any term increasing indefinitely with the time. Mean noon at any place is determined by the transit of this imaginary body over the meridian of the place, just as apparent noon is determined by the transit of the true sun.

Thus mean time is defined with reference to a natural phenomenon; viz., the transit of the real sun over a given meridian: and we cannot have one length of a mean solar day according to Bessel, and another length according to LeVerrier, any more than we can have different lengths of the apparent solar day.

A mean solar day, according to Mr. Stone's theory, is something totally different from that above defined. It has no reference to the average length of the apparent solar day, but is purely artificial or conventional in character. Practically, Mr. Stone's mean solar day is the time during which the mean *longitude* of the sun increases by some definite amount. Bessel gives one determination of this amount, and LeVerrier a different one: hence Mr. Stone is obliged to employ two mean solar days, which are of different lengths, according as Bessel's or LeVerrier's mean motion of the sun is used. On this principle, every fresh investigator of the sun's motion would require a mean solar day peculiar to himself. We are tempted to ask, What was the meaning of the mean solar day before Bessel's time?

The origin of Mr. Stone's misapprehension on this point seems to be the following. In the ordinary practice of an observatory it is usual and convenient to deduce the mean solar time from the sidereal time supposed to be known, instead of finding it by direct observation of the sun. In order that this conversion of sidereal into mean solar time, however, may be correctly performed, it is necessary to employ the correct mean longitude of the sun at the given instant. Any error in the assumed mean longitude will produce an equivalent error in the mean time deduced; and, if the sun's mean motion be incorrectly assumed, the error of time thus produced will gradually accumulate.

Thus the error of mean solar time as deduced from sidereal time by means of Bessel's formula, which amounted in the year 1864 to a little more than half a second, has increased to a little more than six-tenths of a second at the present time. The increase of the error of mean solar time in nineteen years is in reality rather less than eight-hundredths of a second, whereas Mr. Stone's theory makes it amount to twenty-seven seconds! In fact, the error, according to Mr. Stone's theory, is about three hundred and sixty-five times as great as it should be. The reason is, that mean time is measured, *not* by the sun's mean motion in *longitude*, as Mr. Stone's theory supposes, but by its mean motion in *hour-angle*, which is about three hundred and sixty-five times as great; so that the error in time produced by a small error in the

mean motion in longitude is only about $\frac{1}{365}$ of that which would be produced if the error in time bore the same proportion to the time that the error in the mean motion in longitude bears to this mean motion itself.

If n denote the sun's mean motion in longitude in a mean solar day, then the ratio of the length of a mean solar to that of a sidereal day is

$$360^\circ + n : 360^\circ.$$

And if $n + dn$ denote a slightly different determination of the mean motion in longitude, this ratio will be altered to

$$360^\circ + n + dn : 360^\circ.$$

Hence the measure of the sidereal interval corresponding to any given number of mean solar days will be altered in the ratio of

$$360^\circ + n + dn : 360^\circ + n,$$

$$\text{or} \quad 1 + \frac{dn}{360^\circ + n} : 1;$$

that is, since 360° is nearly equal to $365n$, the sidereal measure of the interval will be altered nearly in the ratio of

$$1 + \frac{1}{366} \frac{dn}{n} : 1$$

instead of in the ratio of

$$1 + \frac{dn}{n} : 1,$$

as it should be by Mr. Stone's theory.

In conclusion, we will test Mr. Stone's theory of mean solar time by supposing an extreme case. Let us imagine that the sun had *no motion* in longitude, but, like a fixed star, retained a constant position in the heavens. On this supposition, mean solar time would be just as intelligible as it is at present, and it is evident that the mean solar day and the sidereal day would become identical with each other; but what would become of mean solar time according to Mr. Stone's idea of it?

MORPHOLOGY OF THE PELVIS AND LEG.

MISS ALICE JOHNSON, at the suggestion of the late F. M. Balfour, has investigated the development of the pelvic girdle and hind-limb of the chick (*Quart. Journ. micr. sc.*, xxiii. 399). On the fourth day of incubation the limb is merely a local exaggeration of the Wolffian ridge, consisting, like it, of a mass of rounded mesoblastic cells crowded together. The first trace of the skeletal parts appears on the fifth day; the mesoblastic tissue of the axis of the limb becoming more condensed, and, by the seventh day, converted into recognizable cartilage. Ossification begins very late. The entire skeletal *anlage* of the girdle and limb is at first continuous, making a T, of which the stem represents the limb, and the cross the girdle running dorsoventrally. The pelvic *anlage* soon expands, above the centrally placed acetabular region, into a broad plate, the ileum; below, and in front, into the narrow pubis. A little later the pectineal process grows out in front from the upper part

of the pubis, and the ischium appears behind as a downward expansion below the acetabulum. The further change consists chiefly in the expansion of the ileum, and in the growth of the pubis and ischium; which last two become inclined backward, and acquire a considerable posterior prolongation. During these changes the pelvis passes through a stage which is permanent in *Apteryx*. The division of the primitive anlage into the skeletal parts is produced by the known histological changes at the joints. The author thinks that Hofmann's 'epipubis' (*Nederl. arch. zool.*, iii.) is the true pubis, and his 'pubis' in reptiles a process of the ischium. She also corrects some errors of Bunge.

These observations throw much light on the homologies of the pubis, of which the pectineal process is a branch, so that the pubis is biramous. A comparison of the bird with mammals (in which the pectineal process is often reduced, and sometimes absent) and dinosaurs at once determines the homologies of the pubis in these forms. In reptiles the pubis has also two branches, — the main body of the pubis; and the

detail with Baur's (*Morphol. jahrb.*, viii.): we therefore note merely the presence of five metacarpals, and the failure to find a separate origin for the intermedium; but, in opposition to Morse, she is inclined to concur with Baur in describing the ascending process of the astragalus as an outgrowth from the tibiale. Morse's conclusion may be due to his having studied different birds (aquatic species). It is a pleasure to praise this excellent paper.

C. S. MINOT.

RECENT WORK ON BRACHIOPODS.

THE important though rather fragmentary observations of Kovalevski on the development of the brachiopods have long remained sealed in their original Russian from western naturalists, who have only had access to more or less incomplete synopses of the original. MM. Oehlert and Deniker have prepared for the latest volume of the *Archives de zoologie expérimentale* a careful analysis of the paper in question, illustrated by rough but sufficiently clear figures reproduced from the original. The result is a paper of some twenty pages, which may be obtained separately, and will have a value for all biologists, whatever their position as to the author's theories.

In a note on *Terebratula* (*Centronella*) Guerangeri, M. Oehlert signalizes the existence of two or three forms of this genus in the Devonian of Europe. He discusses the relations of *Centronella*, *Leptocoelia*, and *Renssellaeria*, and concludes that they probably represent an arrested development, which would, if carried out, bring them into relations with *Waldheimia*, and that they should be referred to the same sub-family. The absence of punctation in the test is referred to metamorphism, as in *C. Guerangeri* all stages were discovered, from impunctate to completely punctate.

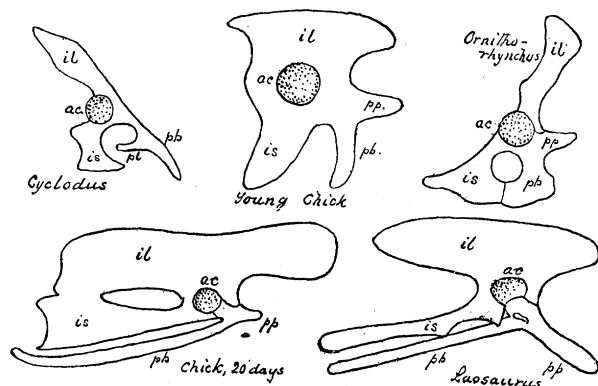
The same author, in the *Bulletin de la société géologique de France*, discusses the Devonian *Chonetes* of western France, where four species are found in the grauwaacke and calcaire beds, but are absent in the grits. One of the species, *C. tenuicostata*, is new, and all are figured; while the characteristics of the genus are thoroughly reviewed.

In the same publication the author describes two new species of *Acroculia* from the lower Devonian of Mayenne, reviews the genus, and shows that the prior name of *Platyceras* Conrad, being doubly preoccupied in insects, must give way to *Acroculia*.

Lingula Norwoodi, from the Cincinnati limestone, is redescribed and figured by U. P. James in the *Cincinnati journal of natural history*.

Glottidia pyramidata Stimpson has been found by Hemphill in South Florida, considerably extending its range, and leading to the suspicion that *G. antillarum* Reeve, described from the West Indies, may be identical with it.

W. H. DALL.



EXPLANATION. — *il*, ileum; *ac*, acetabulum; *is*, ischium; *pb*, pubis; *pl*, processus lateralis; *pp*, pectineal process.

posterior ramus lateralis, which may be wanting, however, as is the case with crocodiles. After discussion of the subject, the writer concludes, we think rightly, that the so-called pubis of reptiles is homologous with the pectineal process, and the lateral ramus homologous with the pubis of higher forms. The homologies are given in the following table, and differ, it will be seen, very widely from those current:—

Reptiles.	Dinosaurs.	Embryo bird.	Birds.	Mammals.
1. Pubis.	Pubis (Marsh).	Anterior branch of pubis.	Pectineal process.	Pectineal process.
2. Processus lateralis.	Postpubis (Marsh).	Posterior branch.	Pubis.	Pubis.

Miss Johnson also investigated the development of the limb. Her observations agree in almost every

THE AMERICAN INSTITUTE OF MINING-ENGINEERS.

THE winter meeting was held at Cincinnati, Feb. 19-22, and was not so numerously attended as usual by reason of the flood in the Ohio, which had so interfered with railroad travel during the preceding week as to keep many at home who had expected to be present.

At the first session, on the evening of Tuesday, Feb. 19, the institute was cordially welcomed to Cincinnati by representatives of the city authorities, of the citizens, of the university, of the Ohio mechanics' institute, and of other organizations.

Mr. Robert W. Hunt of Troy, N.Y., president of the institute, returned thanks in behalf of his fellow-members. The remainder of the evening was occupied by Mr. Arthur V. Abbott of New-York City, who delivered a lecture on physical tests of metals, in which he gave a lucid description of the Fairbanks automatic testing-machine at New York. Diagrams of the various parts of the machine were thrown upon the screen, including representations of the novel contrivances employed for the automatic registration of stresses and strains, as well as some of the autographic sheets, which showed how the ultimate tensile strength of short bars differs from that of longer ones of the same material and same cross-section. The machine has a capacity of two hundred thousand pounds for either kind of stress, — tension, compression, torsion, etc. (see p. 312).

The session of Feb. 20 was opened with a paper by Mr. Magnus Troilius of the Midvale steel-works, Philadelphia, describing and advocating the bromide process for determining the sulphur in steel; and this was followed by a supplementary paper, by the same author, giving tables for facilitating the heat-calculations of furnace-gases containing CO_2 , CO , CH_4 , H , and N .

The next paper, by Mr. George C. Stone of Newark, N.J., was on further determinations of manganese in spiegel, being a continuation of a paper presented at the Troy meeting, in which the results of many analyses of spiegel by different chemists were tabulated, and the comparative value of the chemical processes employed was discussed.

The next paper read was by Dr. T. Sterry Hunt of Montreal, on the apatite deposits of Canada, their distribution, richness, and value, the amount at present annually exported, the economic conditions for mining it, etc.

Mr. Nelson W. Perry of Cincinnati exhibited specimens of a new mineral discovered by him near Ramos, San Luis Potosi, Mex., for which he proposed the name ramosite. Its hardness is nine in the scale, being next to the diamond; its color, black; its specific gravity, 3.83. Mr. Perry also exhibited crystals of topaz found in Mexico, some of which were as much as an inch in diameter, occurring in the unusual matrix, trachyte.

After a paper by Mr. Frank Firmstone of Easton, Penn., on incrustations in pig-iron, a report was made by Dr. Thomas Egleston of the Columbia school of

mines, New York, on the bill now pending before Congress to re-establish a commission for testing the strength and other properties of iron, steel, and other materials of construction. He earnestly disclaimed any intention of interfering in any manner with the use of the Emory testing-machine at Watertown (built by the last commission), or of having it removed to any other locality, and urged that all legitimate influence be brought to bear to have the bill passed.

In an elaborate paper by Mr. S. Stoltz of Pittsburgh, Penn., on coal-washing, elevating and conveying machinery, the plant employed by him in handling soft coal was explained in detail by the aid of numerous diagrams.

Professor Lord, of the Ohio state university, Columbus, gave the results of analyses of certain Ohio clays.

A paper by Mr. Joseph H. Harris of Philadelphia, on the benefit fund of the Lehigh coal and navigation company, gave a *résumé* of this and various other forms of life and accident insurance for the benefit of miners, and compared the usefulness of the different plans which have been adopted in Pennsylvania; it being a matter of extreme difficulty and delicacy to arrange a plan which works well, in face of the strained relations often existing between the miners and their employers.

The session of Feb. 21 was opened with a lecture by Dr. A. A. Springer of Cincinnati, on torsion, illustrated by diagrams. He was followed by Prof. William L. Dudley of Cincinnati, who explained somewhat minutely the new process of electroplating with iridium, and exhibited specimens of articles so plated.

A paper by Mr. Pedro G. Salom of Thurlow, Penn., giving the results of the analyses and tests of steel used in the U.S. cruisers now building at Chester, Penn., was, by reason of the important and remarkable results obtained, made the special order for the next meeting of the institute.

The officers elected at this meeting were:—

President, James C. Bayless, New-York City; vice-presidents, Eckley B. Coxé (Dufton, Penn.), Thomas Egleston (New York), Edwin C. Pechlur (Cleveland); managers, Edward S. Cook (Pottstown, Penn.), Frank Firmstone (Easton, Penn.), C. W. Maynard (New York); treasurer, T. D. Rand, Philadelphia; secretary, Rossiter W. Raymond, New York; scrutineers, S. T. Williams, J. T. Lewis.

The annual report of the secretary showed a total membership of 1,341, which was largely increased at this meeting.

The meeting was a success, not only in a professional and scientific way, but socially as well. The institute invited its Cincinnati friends to dinner at the Grand Hotel on Wednesday evening; Mr. and Mrs. T. B. Aldrich entertained the institute, at their residence on Mount Auburn, on Thursday evening; the Southern railway provided an excursion to the high bridge over the Kentucky River, with special train of Pullman cars, and lunch, on Friday; and the institute was invited to attend the opera festival to hear Nilsson on Friday evening.

GEOLOGY OF THE GRAND CAÑON.

Tertiary history of the Grand Cañon district. By CLARENCE E. DUTTON. (Monographs U.S. geological survey, ii.) Washington, *Government printing-office*, 1882. 264 p., 42 pl. 4°. Atlas, 23 sh. f°.

THIS work is the second in numerical order, though the first in date of publication, of the monographs of the U. S. geological survey. It is not a geological report in the generally accepted sense of the term, but deals strictly with the physical problems displayed by the Grand Cañon district, and, as its title indicates, principally with that part of its history embraced in the tertiary period, of which the distinguishing feature in this region is denudation on a stupendous scale.

The first geological exploration of the Grand Cañon of the Colorado is due to Major Powell; and for several years his name was closely associated with the progress of discovery in this field. Finding himself, however, unable to continue the work, it was delegated to Capt. Dutton, who had already become familiar with some parts of the district; and the present monograph is the best possible evidence that Major Powell has found no unworthy successor in his investigations.

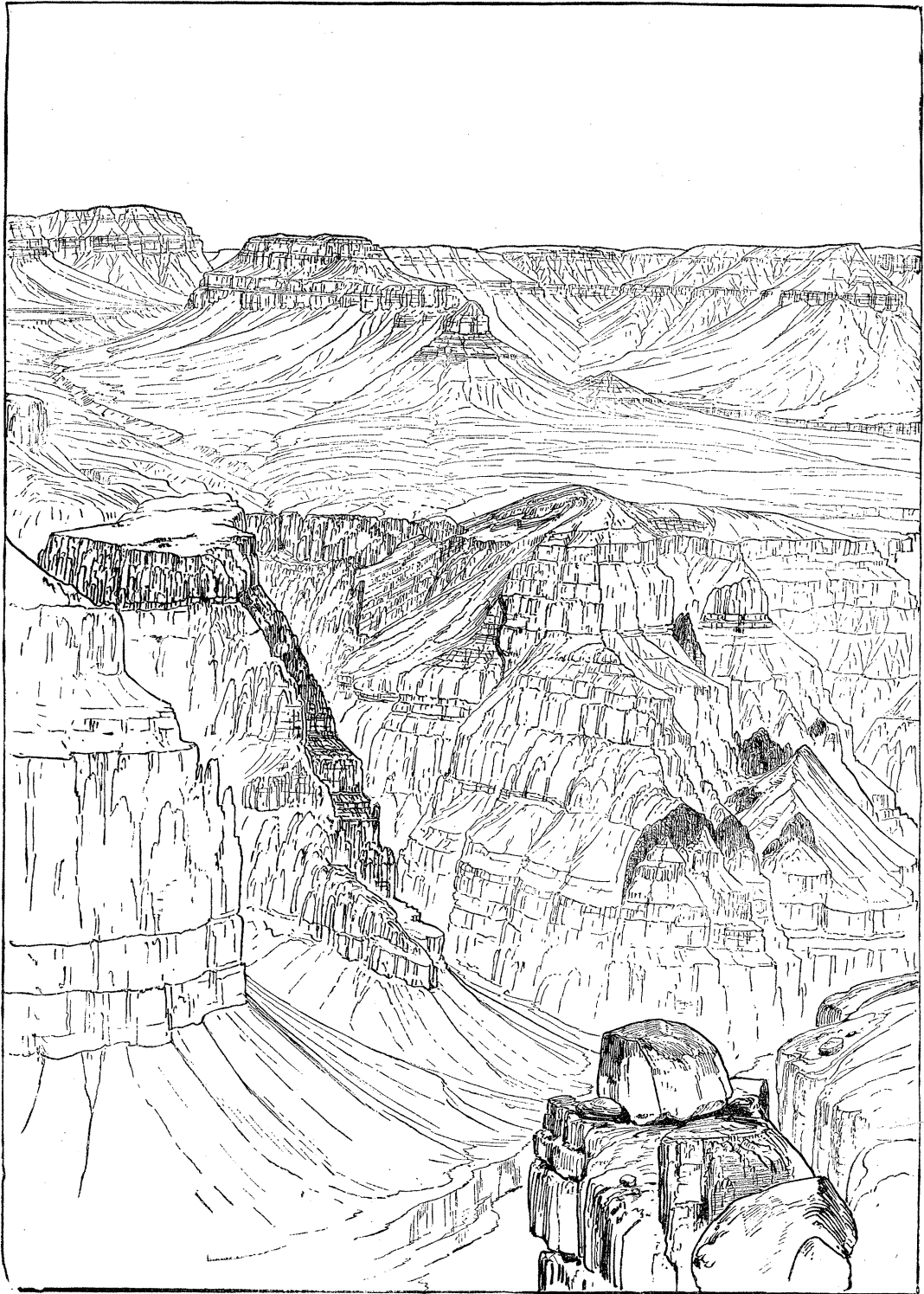
Capt. Dutton writes as one in love with his subject; and it would indeed be surprising if any geologist who has had the privilege of studying this region were otherwise than enthusiastic in regard to it. A large part of the western territory is such that the geologist who runs may read; that even from the windows of the railway more facts may be gleaned in a day's journey than could be certainly arrived at by months of study in a wooded country, or one mantled by the northern drift. In addition to these advantages, common to vast tracts, the Grand Cañon presents the most striking river-section in America, and perhaps in the world. In such a field a more complete knowledge of the problem is possible, and a closer and more logical method in its treatment admissible, than elsewhere, — circumstances fully taken advantage of in the present report.

The high plateaus of southern Utah descend to the south in a succession of gigantic terraces, composed in succession of the eocene, cretaceous, triassic, and Permian formations, till the summit of the carboniferous is eventually reached. This forms a wide platform, with some approach to regularity of surface, but drops at length in an escarpment of great cliffs to the desert and sierra regions of the farther south and west. The terrace country has a

width of from thirty to forty miles, with a length of about one hundred, and forms, as it were, a giant stairway, leading down from the high plateaus, with an elevation of over ten thousand feet, to the carboniferous platform, five thousand feet or more lower. The whole rock series has a preponderant northward dip of an extremely regular character, which seldom exceeds two degrees, and is generally less than one degree, in amount. The carboniferous surface presents a corresponding light slope from south to north; and the strata are traversed by a series of faults and congenetic monoclinical flexures, running in north and south courses, but showing a convexity toward the west. These define the several minor plateaus which diversify the surface; but the region, as a whole, is characterized by the proximate horizontality and undisturbed condition of its rocks, and is in marked contrast to the turmoil of flexed beds found in the adjacent sierra country. Across the carboniferous platform, in a general south-westward course, the great cañon has been cut, — a vast chasm, with a total length of about two hundred miles, a depth of from five thousand to six thousand feet, and a width of from five to twelve miles.

The history of the cañon district, from the later paleozoic to the present day, is naturally divided into two widely contrasted periods; the first extending from early carboniferous time into the eocene, having been one of steady, conformable deposition, bed succeeding bed, till a thickness of about fourteen thousand feet was accumulated. To this succeeded a period of continuous erosion, during which an average thickness of ten thousand feet of the strata was removed from a large part of the surface.

Though rather heterogeneous in character as compared among themselves, the beds of the Grand Cañon region in general closely resemble those representing the same horizons in other parts of the west. The archæan and other basal rocks, not throwing any light in the physical problem proposed in the monograph, are merely mentioned. The carboniferous, broadly viewed, may be characterized as chiefly limestone; and the conditions of a somewhat deep sea at the time of its formation are implied. The Permian and triassic are mainly represented by sandstones, which frequently display cross-bedding, and denote that the water at the time of their deposition was continuously shallow. In the cretaceous, argillaceous and marly rocks become more abundant; and the occurrence of coals and carbonaceous layers throughout, shows that portions of the region became land-surfaces from time to time.



DIKES IN THE CAÑON WALL OF THE INNER GORGE, GRAND CAÑON OF THE COLORADO.

This period closed amid important disturbances ; as, in neighboring districts, the succeeding beds are occasionally found to rest directly on the Jura-trias, or basset edges of the cretaceous. As a result of these movements, a great eocene lake was formed, which appears to have been not far above the sea-level, and to have outflowed southward. The change from salt to fresh water conditions is quite sudden. During the eocene period this lake gradually shrank back, and finally disappeared to the north, near the base of the Uinta Mountains, where alone the later eocene deposits are found.

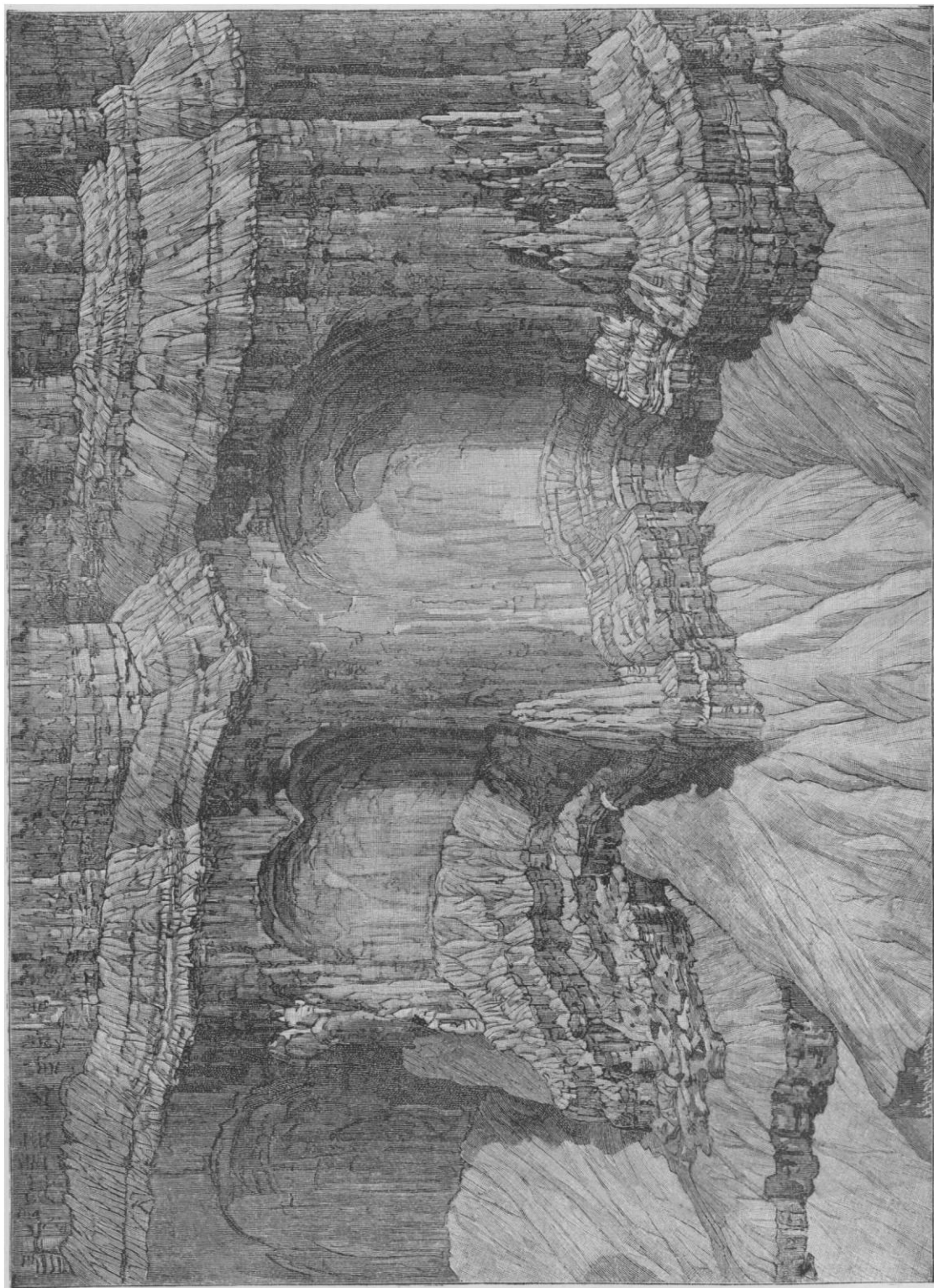
The author finds a little difficulty in explaining the great horizontal similarity in character of the materials laid down during the later periods in a wide expanse of water so persistently shallow. It is suggested, however, that the very shallowness of the sea or lake may, by insuring a constant sectional area, have resulted in maintaining the velocity, and consequent transporting-power, of any currents which existed. The continuance of shallow-water conditions also proves that the profound subsidence required by the volume of the sediments was not acquired suddenly, but that the two increased *pari passu*.

With the eocene the immensely prolonged period of subsidence came to an end, and elevation — shown to have been somewhat spasmodic — and consequent erosion began. It is found by reducing the faults and flexures of the region, and taking into consideration the thickness of the beds, that at this time the carboniferous must have lain over considerable areas, at a depth of from ten thousand to twelve thousand feet below the level of the sea ; and it is interesting to remark in passing, that no great degree of alteration appears to have resulted from this deep burial in the earth's crust. The present altitudes of the plateaus mark the difference between the amount of the succeeding uplift and that of denudation ; and it is shown that the total movement in elevation has been in different places from twelve thousand to eighteen thousand feet.

The 'great erosion,' as Capt. Dutton names the second period of the history, began at the time of the drainage of the eocene lake, of which there is good reason to believe the Colorado still marks the position of the deepest portion. The immutable permanence in position of the channels of the Colorado and its main tributaries, and the fact that they have been able thus to maintain their original courses in opposition to the superimposed northward dip of the beds, is one of the most striking facts brought out in the study of this

district, being, in fact, that which has been most influential in impressing it with its peculiar features. In the latter part of the eocene, and in the miocene, great progress was doubtless made in the removal of the mesozoic strata. The process of elevation continued, and rapid corrosion by numerous streams made steady progress ; the Colorado, at this time, probably flowing in a cañon walled by these mesozoic formations, the escarpments of which have now retreated to the terrace district, fifty miles or more to the northward. Through all this lapse of time we are, however, without any very precise data as to the progress of the erosion ; and it is not till a date approximately referred to the close of the miocene that any measure of the waste accomplished can be arrived at. The elevation of the district was then for a time arrested ; and the streams reached what the author, following Major Powell, calls a 'base level of erosion,' in which, with the production of a uniform light gradient, the wear of their channels ceased, and denudation acted only in reducing the probably rough and irregular features of the neighboring country to an approximate level. The Permian strata apparently at this time constituted the actual surface.

About the time at which the Colorado began to cut into the carboniferous rocks, a climatic change occurred, which resulted in producing very arid conditions, and dried up the smaller streams to their sources. This, from what is elsewhere known of the western tertiary, is presumed, with great probability, to be synchronous with the close of the miocene and beginning of the pliocene. Nearly contemporaneous with these events was an uplift of two thousand to three thousand feet, and the outpouring of the earlier basalts, which, forming protective cappings, have preserved portions of the Permian surface above alluded to. The great faults, also, about this epoch first betray their existence ; though it is by no means certain that all were then formed, and the evidence is clear that their throw subsequently continued to increase gradually. Corrasion, or the wear by the rivers of these beds, now again became active, but only in the case of the larger streams, which, by reason of their origin in high, well-watered uplands beyond the cañon district, had been enabled to survive. A base level was soon again reached : and the Colorado remained during the greater part of the pliocene at the level of what Capt. Dutton calls the esplanade, or wide upper valley of the present cañon ; which valley continued to increase laterally, but not in depth, till the



NICHES OR PANELS (OVER 600 FEET HIGH) IN THE RED WALL LIMESTONE, GRAND CANYON OF THE COLORADO.

final paroxysm of upheaval set in, producing a further rise of from three thousand to four thousand feet. The faults, which are strictly correlated with the varying uplifts of the several minor plateaus, again increased their displacement; and at the same time, or shortly afterward, the volcanic forces resumed their activity, producing cones of eruption which still display their characteristic form. These, and the lavas erupted from them, afford evidence, that, though the cañon had at the time a considerable depth, the greater part of its excavation still remained to be affected by that last great effort of corrasive action which has only lately come to an end.

It is believed that the elevation of the plateau region has now ceased, and that the rivers have again nearly reached a base level of erosion. Some, at least, of the faults cut the older basalts; but no evidence has been found, where the newer lavas cross them, of any renewed movement. The glacial period passed over this region without leaving any traces of ice-action, manifesting its occurrence merely as a pluvial episode, very brief in comparison with the stages of the great erosion, but of which some effects may nevertheless be traced.

Such is a very brief and necessarily imperfect outline of the train of reasoning in which the author follows out the exceptional processes which have acted in the Grand Cañon district, and eventuated in producing its present remarkable features. Very few of the conclusions arrived at are open to any question; and, though it has been for so short a time known to science, it may be considered as one of the most fully thought out of geological problems. Among the collateral facts illustrated in this region are several, which, from their apparently anomalous character, are of special interest to the student of dynamical geology. Such is the want of coincidence between the great faults and points of volcanic eruption, the bending-down of the strata along the dropped sides of the faults, the connection of the latter with the peculiar monoclinical flexures, the not uncommon reversal in direction of throw in the opposite ends of a single fault, and the remarkable observation that the general light dip of the strata is increased notably at the bases of the terraces. The last-named circumstance the author is disposed to connect, though doubtfully, with the theory of plastic equilibrium in the earth's crust, — a theory which we believe few geologists will be ready to follow so far.

A notice of this monograph would be incomplete without special reference to the accom-

panying atlas, containing geological maps and panoramic views of the district. The latter, together with a number of illustrations in the volume itself, are from the pencil of Mr. W. H. Holmes, and convey a better idea of the proportions and intricacy of the physical features than could be accomplished by any word-painting, however elaborate.

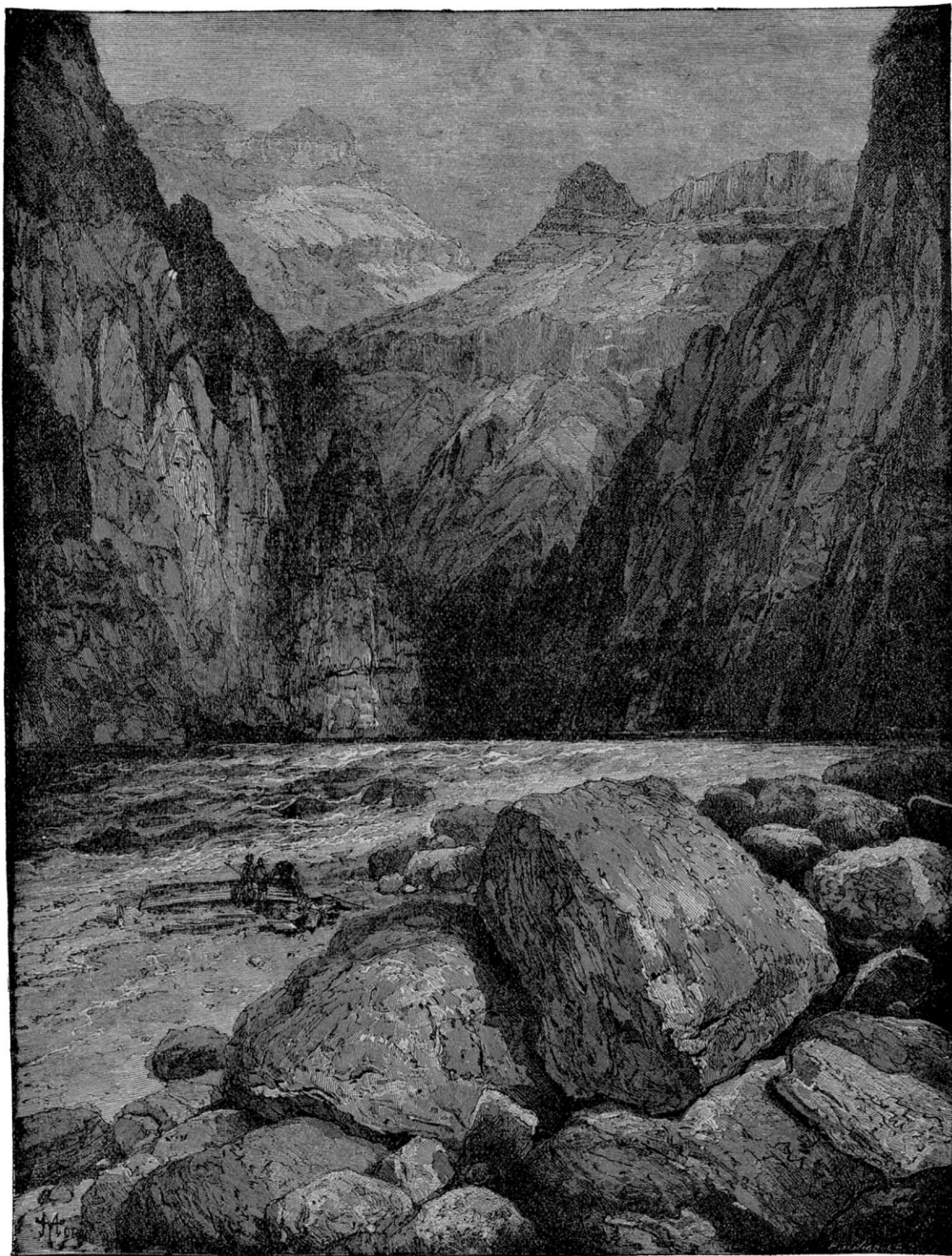
If the character of the critic must be maintained in reviewing this work, which in its main features demands our praise alone, it may be suggested that the 'effusive' style adopted in some of the chapters is scarcely in keeping with the incomparable dignity of the subject, and is not likely to appeal to the specialists for whom this class of publication is intended.

THE BACILLUS OF BERIBERI.

Etiologia e genesis do beriberi. Pelo Dr. J. B. DE LACERDA. Rio de Janeiro, *Faro & Lino*, 1884. 68 p., illustr. 8°.

THIS pamphlet gives the results of a medicobiological study, carried on in the physiological laboratory of the National museum of Rio de Janeiro, on a very obscure disease, which, introduced many years ago in Brazil from India, carries off annually a large number of victims, particularly in the northern provinces of the empire.

Employing the method of Pasteur, and introducing blood of beriberi patients in meat-solution, Dr. Lacerda obtained in numerous experiments a microphyte similar in form to the bacillus of carbuncle. This organism, which reproduces itself by segmentation and by spores, was also found in the fresh urine and blood of beriberi patients, the spores being at times extremely abundant in the blood. On making subcutaneous injections of the liquid in which the organisms were cultivated, in rabbits and guinea-pigs, these animals were found to succumb in periods of from five to twenty days, some of them presenting a true paralysis of the posterior members; others, a notable weakening of these members, with difficulty of locomotion, and loss of cutaneous sensibility. Death in many cases was caused by asphyxia, the paralysis having extended to the anterior members. The cultivated blood of these animals reproduced the same microphytes that had been obtained from the blood of beriberi patients. The microscopic examination of the spinal medulla and of the muscles revealed the presence of the microphyte and of its spores, their abundance in the medulla being especially remarkable.



GRANITE FALLS, A SCENE IN THE INNER GORGE OF KAIBAB DISTRICT, GRAND CAÑON OF THE COLORADO.

From these facts the author draws the logical conclusion, that beriberi is a parasitic disease, and that the parasites attack particularly the blood, muscles, and medulla. In seeking the origin of the parasite, it was found that similar organisms were found at times in rice-grains. The characteristics of the grains of rice attacked by the parasite are given; and the hypothesis is advanced, that rice is often the vehicle of the microphyte by which it enters the human system, which appears to be in accord with the fact that rice is a principal article of food in the regions subject to the disease.

Contaminated grains of rice, subjected to the same cultivation as the blood of beriberi patients, produced organisms entirely identical in appearance. Injections of the liquid of the rice-culture in guinea-pigs produced death in thirteen, seventeen, and twenty days, with paralytic phenomena, and death by asphyxia; and the microscopic examination of the spinal medulla and muscles showed the presence of the same organisms found in animals inoculated with the blood-culture of beriberi. The author proposes to continue his investigation of the suspected relation between a rice diet and beriberi.

BIOLOGICAL THEORIES OF AN ARTIST.

Morphology. Estimates of intelligence. Vital chemistry. By FRANK B. SCOTT, artist. Buffalo, Bigelow pr., 1883. 16 p. 8°.

THE author says in his preface, "If we fail in proving the truth of what we advance, our labor will not be lost: we may lead the way to further discoveries. Columbus was mistaken in his seeking another way to India, but his mistake led to the discovery of a new continent." In science great continents of knowledge never have been discovered by ignorant adventurers: we therefore do not believe that Mr. Scott will achieve the important success he dreams of, although he is mistaken in perhaps half his statements. We are acquainted with no other publication, purporting to be scientific, which contains so many amusing errors and entertaining hypotheses in so few pages. We need only give the following extracts in our justification. "Without oxygen, hydrogen, nitrogen, and carbon, we have no knowledge of life. . . . There are other elements subordinate to these. There is also some other element not subordinate. . . . Perhaps this fifth element was the *quint*-essence of the ancients. Huxley, in his 'Biology,' calls it electricity." Will the author kindly refer us to authority on the quintessence of life of

the ancients; also to the page of Huxley? He further states that the blood at one moment is red with oxygen; the next, black with carbon. We have no doubt that sufficient carbon might blacken the blood, but we are surprised to learn that the mixture occurs regularly during life. The whole pamphlet resembles these samples.

THE ILLINOIS GEOLOGICAL REPORT.

Geological survey of Illinois. A. H. WORTHEN, director. Vol. vii., Geology and paleontology. Springfield, State, 1883. 4+373 p., 31 pl. 8°.

THE first two volumes of this series of reports appeared in 1866; and the others have followed at intervals since then, the seventh having appeared during the past year. The leading feature of these reports is paleontology, in connection with which the names of some of the ablest American paleontologists appear.

In his preface to the present volume, Mr. Worthen says, that to complete the paleontology of the state upon the plan originally contemplated will require two volumes more, with from forty to fifty plates of illustrations each, but that this cannot be done until authorized by special legislative act. It is not improbable, therefore, that the present volume will be the last of the series.

Mr. Worthen's chapter, of fifty-one pages, on economic geology, treats mainly of local sections in different parts of the state, principally of coal-measure strata. He announces the discovery of 'coal-oil' in the town of Litchfield, — a dense lubricating-oil, mingled with salt water, which he thinks comes from the base of the coal-measure conglomerate, or one of the upper Chester sandstones.

Four borings have reached the oil at a depth of nearly seven hundred feet, each boring yielding about two barrels of crude oil per day. He also reports the discovery of brine in Perry county. Six borings have been made, each flowing sixteen gallons a minute, from which an aggregate of thirty-five hundred barrels of salt is made annually.

The work on the fossil fishes by Orestes St. John and Mr. Worthen is a very important one, embracing two hundred and eight pages and twenty-six plates. It treats of those characteristic carboniferous families, the *Cochliodontidae* and *Psammodontidae*, and also of *Ichthyodorulites*. The important works on similar fossil fishes, which were published in previous volumes, are well known; and yet the material now published is unexpectedly comprehensive as regards the variety of forms

embraced in the two families just named. The authors describe and figure fifty-six new species of the Cochliodontidae, together with eight species previously published. They embrace, in all, fourteen genera, six of which are new; namely, *Vaticinodus*, *Stenopterodus*, *Chitonodus*, *Deltodopsis*, *Orthopleurodus*, and *Taenodus*. The last is a hitherto unpublished name, proposed by de Koninck. Of the Psammodontidae, thirteen species (eleven new) are described and figured; eleven of them being referred to *Psammodus*, and two to *Copodus*. Eleven genera are recognized among the Ichthyodorulites, one of which, *Eunemacanthus*, they propose as new. Of these genera, they describe and figure twenty-two species, only two of which have before been published. The specific and generic descriptions are full and clear, and Mr. St. John has made good use of his large experience in their discussion.

Pages 269-322 and four plates are devoted to descriptions and figures of fifty-five species of crinoids, together with a few carboniferous shells. Descriptions of all these except one of the shells were published by Mr. Worthen, without illustrations, in 1882, in Bulletin No. 1 of the Illinois state museum of natural history.

On pp. 323-326 he describes eight species of carboniferous mollusca without illustrations.

Pages 327-338 and one plate are occupied by Worthen and S. A. Miller's descriptions and illustrations of nine forms of echinoderms. Their material for this study was imperfect, and yet they have proposed five new genera; namely, *Compsaster*, *Cholaster*, *Tremaster*, *Hybochinus*, and *Echinodiscus*. The latter they refer to the Agelacriniidae, together with *Archaeocidaris*.

Pages 341-357 are occupied by Mr. Charles A. Wachsmuth. He figures and redescribes, in this volume, two echinoderms which he had

previously described in the bulletin of the Illinois state museum of natural history. Following this, he gives an important discussion of certain blastoids, with a description of a new genus, namely, *Heteroschisma*.

The text of the volume closes with descriptions of three new species of blastoids by Prof. W. H. Barris. They are, however, without illustrations, except one woodcut. Professor Barris refers one of these species to *Pentremites* Say, and the other two to *Elaeacrinus* Roemer. He rejects the generic name *Nucleocrinus* Conrad, because of the erroneous description which Conrad gave of it. *Nucleocrinus* is, without doubt, identical with *Elaeacrinus*; but unfortunately Conrad's type specimen, which is still extant, shows plainly that he mistook its base for its summit. Diagnoses are seldom perfect, and it is difficult to determine how much of error we ought to overlook in the retention of imperfectly defined genera.

The letterpress and binding of this book are creditable; but the illustrations are not up to that standard of excellence which was attained in the previous volumes, and which the present state of art demands. Still, they serve well for the identification of the objects which they are intended to illustrate. The make-up of the book has one inexcusable deficiency, which was, no doubt, due to an oversight, since the other volumes are free from this defect. We refer to the absence of any table of contents, or any reference in the index to the different authors, or the titles of their subjects. This does not detract from the merit of the work, however, which is, as a whole, very great; and the people of Illinois may well be proud of what has been accomplished by their geological survey, even if it should now be suspended.

INTELLIGENCE FROM AMERICAN SCIENTIFIC STATIONS.

GOVERNMENT ORGANIZATIONS.

Geological survey.

Work in the District of Columbia. — It is intended to map about three hundred square miles of the region about Washington, including the District of Columbia and adjacent country on the north, east, and west, extending to a distance of about ten miles from the district boundaries in those directions. This map will be used for the delineation of the geological features of the district and adjacent country, the investigation of which has been carried on for some time by Mr. W. H. McGee. The topographic

work done so far consists mainly of the compilation and transference of material furnished by the Coast and geodetic survey in the form of original unpublished sheets upon a scale of 1-15,000, with contours twenty feet apart vertically, and covering the greater part of the area required for the immediate use of the geologist. Mr. S. H. Bodfish has been assigned to the topographic work, and will utilize all work previously done in the area above indicated by the coast-survey and the commissioners of the district.

Springs of Florida. — Prof. L. C. Johnson, while working in Florida during January, gave some attention to the springs and wells in the vicinity of

Jacksonville. He says that within five miles of Jacksonville is a remarkable spring, known as the Moncrief spring, the waters of which seem to be identical with those of the excavation at the city water-works and of many of the springs of this portion of the state. They differ from those of the southern and western portions in being more decidedly chalybeate. In temperature they are decidedly similar. All those near Jacksonville have temperatures of 72° F., and are said to be almost invariable, summer and winter. The extreme range is two degrees; that is, from 72° to 74°. The deep wells, the shallow ones, and also several lake-like springs, all register 72° F. Some are in superficial strata, reaching a depth of only fifteen or twenty feet; others are from thirty to forty feet deep in clay and rock; and some artesian wells penetrate to two hundred feet.

Chemical division. — During January and February Prof. F. W. Clarke and Dr. T. H. Chatard have been busy in the analyses of mineral waters. Among them, Professor Clarke has examined water from the Helena hot-springs of Helena, Montana Territory, which is an alkaline saline water, and water from the warm springs of Livingston, Montana, which is a calcic sulphur-water. Both are thermal, and these are probably the first analyses ever made of them. Dr. Thomas Chatard has also finished some analyses of Damourite from the well-known topaz locality at Stoneham, Me.

At New Haven, Messrs. Barus and Hallock, during January, were engaged in experiments to determine the exact boiling-point of zinc.

The north wind of California. — Mr. Gilbert Thompson, while engaged in topographical researches in the Cascade-range section of California, has been incidentally collecting information concerning what is generally observed as the 'north wind of California,' as it was first observed in that state, and supposed to

be local. The name, however, should not be so restricted, as it should be extended to the Pacific slope of the United States and possibly of North America. The characteristics of this wind have been more particularly described by Dr. J. H. C. Bonté, of the University of California, than by any one else. To describe them briefly, they are included under the head of excessive drying-qualities. These are marked both in summer and in winter. In the former, vegetation sometimes appears as though it were burnt, and the effect upon both animals and men is striking. Men who have recently arrived in the country, and are robust, are not so sensitive to the wind as residents; and it has therefore been said that the imagination has a great deal to do with it, but this is a mistake. It matters not whether the wind is hot or cold, it produces a feeling of great depression and nervous irritability, lassitude, and restlessness. Some call it the 'poison wind,' and others the 'crazy wind.' The effects produced are similar to those of the 'Puna wind' of Peru, and the 'Hammattan' of Africa. It blows at no regular interval, nor for any known definite periods. There is some local authority, however, for the opinion that some multiple of three has been observed by some of its recurrences. The wind is really vicious only once in eight or ten years; and it undoubtedly has a powerful and favorable effect in drying up the wet soil, and neutralizing the effects of the rank vegetation, in the Sacramento valley after the rainy seasons. Mr. Thompson has, so far, traced its course and width to latitude 42°; and such information as he possesses to date seems to indicate that the wind moves down along the east base of the Cascade range, and thence through the Sacramento and San Joaquin valleys of California. There are numerous theories as to its origin, and the reasons why it produces such marked and peculiar effects.

RECENT PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Academy of natural sciences, Philadelphia.

Feb. 12. — Dr. N. Roe Bradner exhibited an inscribed stone found inside a skull taken from one of the ancient mounds at Newark, O., in 1865. An exploration of the region had been undertaken in consequence of the finding of stones bearing markings somewhat resembling Hebrew letters, in the hope of finding other specimens of a like character. The exploration was supposed to have been entirely unproductive of such objects, until Dr. Bradner had found the engraved stone now exhibited in a skull which had been given to him. The specimen is of a dark reddish material, of a rounded wedge shape, and bears on its surface a number of characters, the significance of which had not been determined, but which resemble the markings on the specimens before discovered. — Rev. H. C. McCook described the nests of a new species of spider recently received from Mr.

W. G. Wright of San Bernardino, Cal., for which he proposed the name *Segestria canites*. The cocoons hang in strings from the limbs of trees extending over a pathway. They are placed one above the other to the number of eight, and are united by a netting of white silk, covered with the leaves of the neighboring plants. They are kept in place over the path by lines which extend to either side, sometimes to a distance of five feet. Along one side of the suspended nests is a tube, which is inhabited by the mature spiders. As the weaving of nests over pathways leads to their being frequently torn away by passing animals, it had been suggested that the case was an illustration of a weakening of the instinct of preservation. It may, however, be rather a means adopted for the distribution of the species; the spiderlings being doubtless carried to remote points by the animals which tear away the nests. — Mr. Edward Potts reported that he had examined the fore-bay at Fairmount water-works, from

which the water had been temporarily withdrawn, with a view to discover the winter condition of the fresh-water sponges and other inhabitants of that locality. Where the surface could be reached, it was found to be covered with a mud-colored incrustation of considerable thickness, which proved to be composed almost wholly of the statoblasts and spicules of the sponge *Meyenia Leidyi*. Some few fragments of *Meyenia fluviatilis* and *Spongilla fragilis* were seen, but the first named was clearly the prevailing species. A disused sluice-way was covered with a dry incrustation of the same material. While considering the effect of the presence of so large a sponge-growth at the inlet to the supply-pumps, Mr. Potts stated that *Meyenia Leidyi* was conspicuous among the known North-American sponges by its great relative density, and the small proportion of its sarcode or flesh. Its decay, therefore, at the termination of its period of summer growth, would be a slighter cause of pollution to the water-supply than that of any other species. He was, moreover, inclined to believe that decay was not the normal or necessary result of the close of each season's growth. The fragile branches of some species inhabiting exposed situations may, of course, be broken off and destroyed while the sarcode still covers them; but in the sessile portions, and in all when sufficiently protected, the cells of the sarcode at the period of full maturity, forsaking their places along the line of the skeleton framework, gather together by simultaneous amoeboid movement into dense groups, where they are soon covered by a tough chitinous coat, which, in turn, generally becomes surrounded by a crust of minute granular cells, and armor-plated by a series of protective spicules. These groups are now recognized as the statoblasts, gemmules, or winter eggs of the sponge. They are eggs only in appearance, being in reality the resting-spores or protected germs which conserve the life of the individual through the cold of winter. This life-history indicates rather a condensation than a decay of substance as winter approaches, and leaves little or no reason to regard such organisms as a source of water-pollution.

Feb. 19. — Mr. Thomas Meehan exhibited twigs of the plant used by the Piutes and other western tribes of Indians for making baskets. They proved, on examination, to belong to *Apocynum cannabinum*, the species used by the eastern Indians for a like purpose. — Mr. Meehan called attention to sections of trees from Schuylkill county, Penn., illustrating remarkably slow growth. A black oak, *Quercus tinctoria*, in a little over two inches from the centre, had an average of thirty-six circles to an inch; one of hen lock spruce, fifty-one circles to an inch; and one of the common chestnut, twenty-four circles to an inch. Though only four inches in diameter, the oak stem was seventy-six years old; the hemlock, four inches in diameter, was one hundred and four years old; and the chestnut had grown only four and a half inches in diameter in sixty years. He believed two hundred years to be the full average duration of most of the trees of the eastern United States. — The same speaker, referring to the supposed parasitic

nature of the snow-plant *Sarcodes sanguinea*, of the Rocky Mountains, stated that he had carefully examined a specimen growing at an elevation in the Yosemite Valley, and found it to be existing independently, no connection being traceable with either living or dead roots. No trace of vegetation was found in the soil which was carefully washed away, but a huge mass of coralline fleshy matter, out of which the inflorescence arose. The origin of this fleshy mass was yet an unsolved mystery. From analogy with the behavior of other plants, he was inclined to believe that there was some parasitic attachment in the early life of the plant, and that it stored up in this coralline mass enough nutrition in one season to support the inflorescence, after which the connection was severed. — Mr. Meehan also exhibited the dried leaves and fruit of *Halesia diptera*, H. tetraptera, and of a remarkable departure raised from the last-named species some years ago. This appeared in a bed of seedlings, all raised from seed gathered from one tree growing in a garden in Germantown. It attracted attention, when one year old, by the leaves bearing a resemblance to those of an apple-tree. The original tree had leaves narrowly lanceolate and acuminate, rather thin, pale green on the upper surface, and with no particularly prominent veins. The plant in question had broadly ovate leaves, scarcely pointed, very dark green, rugose on the upper surface, and strongly veined and hirsute below. The flowers, when they appeared, were open cup-shaped, instead of being drawn into a narrow tube at the base, as in the parent plant; and the pistil was wholly enclosed, and not exserted. For several years the plant was sterile; and many good botanists, whose attention was called to it, regarded the plant as a hybrid, and the sterility as a proof thereof. It was of no avail to point out that there was no other species from which the parent could have obtained pollen within many miles, nor to show that hybrids were not necessarily sterile. This season, however, the plant produced fruit. It is very small, not much over a quarter of an inch in diameter, and the four equal wings are comparatively large and of a strongly coriaceous character. The fruit which had been cut open was found to have perfect seeds. If the plant, with these leaves, flowers, and fruit, had been found in a state of nature, the botanists would surely have considered it the representative of a distinct species, if not of a new genus. While the suggestion of hybridity might be reasonably excluded, change of surroundings could not be advanced as the cause of the variation, for the environment was precisely the same for the sport, the seedlings which grew without change, and the parent stock. — Professor Angelo Heilprin stated that among a small number of carboniferous fossils obtained from the border of Wise county, Tex., and submitted to him for examination by Mr. G. Howard Parker, a form occurs which can unhesitatingly be referred to the genus *Ammonites*. Only a fragment of a single individual is to be found; and this, unfortunately, has lost the shell, so that no external ornamentation, if any such existed, can now be discerned. This is the first *Ammonites* that has been detected in any Amer-

ican formation below the mesozoic series. The association with it of characteristic paleozoic forms of life, such as *Zaphrentis*, *Phillipsia*, *Bellerophon*, *Conularia*, *Chonetes*, and *Productus*, leaves no doubt as to its position; and hence we must conclude that here, as well as in India, where Waagen first announced the occurrence of true carboniferous ammonitic forms, the distribution of this highly characteristic group of organisms was not so rigidly defined by the mesozoic line as geologists had been led to conclude. That pre-mesozoic Ammonites will be discovered elsewhere besides in India and Texas, there is no reason to doubt; indeed, no assumption could be more illogical than the contrary: and therefore the present discovery is in no way specially surprising, and only interesting rather than important. Special interest, however, attaches to this form; as through it, and the individuals or fragments that have been found in the Tejon (tertiary) rocks of California, we have established in this country the extreme range of the group which it represents. The name *Ammonites Parkeri* was proposed for the species.

Philosophical society, Washington.

Feb. 2. — Prof. C. V. Riley presented a review of recent progress in economic entomology; describing especially the development of insecticide methods and apparatus, and closing his remarks with a plea for applied science. — Dr. Swan M. Burnett discussed the question, why the eyes of animals shine in the dark, giving a short digest of the subject, and describing experiments of his own. He concluded that the phenomenon was caused by reflection from the retina of the eye. It is seen best when the observer is on the line connecting the shining eye with a source of light, and ceases when his station departs from that line by a certain amount. The limiting angle (measured at the reflecting eye) is relatively great in the case of eyes which are hypermetropic. Professor William Harkness pointed out that the limiting angle is likewise affected by the magnitude of the bright image on the retina. — Mr. A. B. Johnson spoke on eccentricities of ocean-currents as illustrated by the voyages of lost buoys. At various times buoys have been torn from their moorings in the waters of the United States, and carried to sea; and eleven of these have been afterward found at distant points, and identified by means of letters cast in their constituent plates. One was found on the west coast of Ireland; a second, at Pendeen Cove, England; two others, just east of Teneriffe; a fifth, near Turk's Island; and a sixth and seventh, near Bermuda. The remainder were found in the open Atlantic, in the following positions: latitude $42^{\circ} 22'$, longitude $26^{\circ} 38'$; latitude $29^{\circ} 46'$, longitude $77^{\circ} 38'$; latitude $30^{\circ} 30'$, longitude $28^{\circ} 40'$; latitude $24^{\circ} 11'$, longitude $32^{\circ} 43'$. Admiral Jenkins cited another instance of a U. S. buoy stranding on the coast of Ireland. In the discussion which ensued, the opinion was expressed by Dr. William H. Dall and others, that the buoys found near Teneriffe had made a northward *détour*, and that those picked up

near Bermuda and Turk's Island might have continued on the same course, and afterwards turned west, completing the circuit of the Sargossa Sea; but it was thought more probable that the latter had followed the southward coastwise current inside the Gulf Stream.

Feb. 16. — Prof. F. W. Clarke spoke on the periodic law of chemical elements, giving the history of the discovery of the law and of its verification by the subsequent discovery of elements indicated by it, and even specifically predicted. He exhibited an enlarged copy of Meyer's atomic-volume curve drawn with the latest values for atomic weights and specific gravities, and presented a similar curve illustrating the connection between atomic weight and melting-point. Each curve presents a series of maxima and minima, the maxima of one corresponding to the minima of the other. The regularities of these curves indicate that the elements originated by some method of evolution, and that a feature of transmutation of one element into another is not impossible. — Mr. Henry A. Hazen read a paper on the sun-glows, which has since been printed in the March number of the *American journal of science*. The first appearance of the phenomenon was at Mauritius, Aug. 28, 1883; and it was next seen at Maranhão, Brazil, Aug. 30. It then appeared at irregular intervals on either side of the equator, until Nov. 26 and 27, when it seemed to burst out over the whole world. After describing the nature of the phenomena, and stating the principal theories which had been advanced to account for them, he proceeded to advocate the vapor theory as follows: *a.* The glows are precisely like the ordinary sunset phenomena, which are known to be caused by the presence of aqueous vapor; *b.* The abundance of the material so uniformly distributed accords with the universality of the glows; *c.* The fact that faint stars and clusters could be easily seen indicates that nothing more opaque than water-vapor or frost-particles could be in suspension; *d.* Frost-particles might be repelled to a great height above the earth, and might be kept there by some form of electrical action; *e.* The fact of the spectroscopy giving no indication of an abundance of moisture does not militate against this theory, because it has been shown that ice-crystals or frost-particles do not affect the spectrum in a rainband spectroscopy. To the volcanic-ash theory he opposed the following objections: 1°. On this theory there must have been sufficient material ejected from Krakatoa, on Aug. 26 and 27, to cover more than a hundred and thirty-five million square miles of the earth's surface; 2°. There must have been currents of nearly equal force, moving in opposite directions from the volcano; 3°. The upper currents must have had a sufficient velocity to carry the ashes twelve thousand miles in a hundred and fifty hours (about eighty miles per hour) toward the west, while meteorology indicates no such velocities, and in general shows the upper current to be always toward the east; 4°. The ashes must have been mechanically distributed over the whole earth by air-currents; 5°. The phenomenon has been markedly intermittent; 6°. Volcanic ashes

are more or less opaque, while the phenomena attendant upon the glows indicate no such opacity. The cosmic-dust theory incurs many of the same objections, besides being inherently improbable. In the ensuing discussion Prof. E. B. Elliott argued that the phenomena were electrical; and Prof. H. M. Paul sustained the volcanic-ash theory, pointing out that Mr. Hazen's conclusion as to the simultaneousness of the first appearance of the phenomenon at remote points depended on a special interpretation of imperfections of the record, depending on cloudiness, and claiming the equal privilege of interpreting them in another way.

Ottawa field-naturalists' club, Canada.

Feb. 28. — Dr. George M. Dawson read a paper on the occurrence of phosphate deposits. After showing that phosphatic materials were essential to the life both of plants and animals, he pointed out that the natural cycle of the rotation of these substances was interrupted by the action of man, and that large quantities of matter which should return to the soil were withdrawn from it and taken elsewhere. The cropping of the soil impoverishes it, and prevents it from yielding as abundantly as formerly, unless the loss is compensated by the application of phosphatic fertilizers. The grain exported from the port of Montreal in a single year has been estimated to contain 2,574 tons of phosphoric acid, which implies the total exhaustion, in as far as phosphates are concerned, of 75,000 acres of good land, to renew which would necessitate the application of some 6,000 tons of apatite. It is easily seen that there must always be, under the present condition of affairs, an extensive demand for phosphatic materials; and it becomes necessary to inquire where specially concentrated natural sources of supply may be found. The occurrence of such deposits was traced from the guano, which accumulates in exceptionally dry climates, on islands frequented by immense numbers of sea-birds, and such recent deposits as the 'mussel muds' of Prince Edward Island, through the so-called coprolite beds of England, Carolina, and elsewhere, to the more concentrated and metamorphosed deposits found in the older rocks of Canada and Norway. The main facts in regard to the mode of occurrence of apatite deposits in the Laurentian rocks of Canada were explained, and the great economic importance of such accumulations was considered. — Mr. Fraser Torrance who, as a mining-engineer, has had large experience with the deposits found in the vicinity of Ottawa, gave a very interesting description of the character of some of the deposits, and of the difficulties met with in working them, owing to the irregular manner of the deposition of the mineral; which cannot be considered as occurring either in veins or in beds, but as passing from one to the other without any regularity of transition. The methods in which the present surface-workings are conducted are such as to throw most serious difficulties in the way of any future mining of the lower deposits. The imperfect manner in which apatite has hitherto been manufactured in Canada was described; and it was stated

that it was highly probable that much of the mineral which was mined in Canada and exported to Great Britain returned, either in the raw or manufactured condition, to the United States. — Mr. F. D. Adams reported the detection by him, in minerals received from Arnprior, of a specimen of rock identical with that in which apatite occurs in Norway, and which had previously been known only from Norway and Finland.

Boston society of natural history.

March 5. — Prof. A. Hyatt read a paper on the larval theory of the origin of cellular tissue. He reviewed the history of investigation among sponges; concluding, that, though true metazoa, they possessed characteristics which showed them to be derived from protozoa. The parallel between the development of the cell and egg in the tissue is strictly parallel with the evolution of nucleated from unnucleated forms in protozoa. Recent investigations have removed all objections to the homology of the egg or any cell with the adult of the nucleated protozoon; and the principal mode of reproduction by division is the same in all these forms. The egg builds up tissue by division after being fertilized by the male or spermatozoon, just as the protozoon builds up colonies after fertilization. Spontaneous division of a cell which undergoes encystment takes place, and the spermatozoa which result from this are true larval monads. These resemble the monads derived from division of the encysted bodies of protozoa in their forms and in their activity. They differ in being able to fertilize the female or ovum at once, instead of being obliged to grow up to maturity before arriving at this stage. Thus all cells may be regarded as larval protozoa, and eggs and spermatocysts as encysted larval forms, the spermatozoa being equivalent also to larval forms which have inherited the tendencies of the mature forms in the protozoa at the earliest stages. Thus the origin of the tissues in the metazoa is in exact accord with the law of concentration and acceleration in heredity. The cells are larval, which, in accordance with this law, have inherited the characteristics and tendencies of their adult ancestors in their earliest stages. The three layers can be accounted for as larval characteristics inherited from colonies of Infusoria flagellata, which had two forms (protective and feeding zoons), and then three (protective, feeding, and supporting), these corresponding to ectoderm, endoderm, and mesoderm. — Dr. M. E. Wadsworth read a paper on the structure of the earth's interior, which he held to be a molten or semi-fluid mass, which will gradually cool and solidify.

NOTES AND NEWS.

THE National academy of sciences will hold its next annual session at the National museum, Washington, commencing April 15, at eleven A.M. An election of five new members will be held. This will not make good the vacancies of the past year; for, of the ninety-eight members on the roll a year ago, six have since died, — Professors Alexander and Guyot

of Princeton, Gens. Humphreys and Warren of the Corps of engineers, Dr. LeConte of Philadelphia, and Professor Lawrence Smith of Louisville. Dr. Engelmann, whose death we recently announced, was an honorary member, and, like all the others, excepting Gen. Warren and Professor Smith, a foundation member. Only eighteen of the fifty foundation members of 1863 now remain. We shall soon print memoirs and portraits of Dr. Engelmann and Gen. Humphreys.

— Another effect of the great eruption of Mount Krakatoa has been recently noticed. It was followed by a series of barometric waves which seem to have spread almost over the entire world. Professor Förster of Berlin says, The great eruption in the Straits of Sunda, which happened on the morning of Aug. 27, gave rise to an atmospheric wave which showed itself for five or six days in the records of the self-registering barometers in all parts of the world. In the barometric markings which are registered by the Commission of weights and measures in Berlin, in order to have a permanent record of the minuter variations, these effects of the volcanic eruption appear with striking clearness.

The first atmospheric wave from this source appeared in Berlin about ten hours after the catastrophe. Supposing it to have taken the shortest course from its origin to Berlin, this time would indicate a speed of somewhat more than a thousand kilometres per hour, agreeing very closely with the velocity of sound. This result is in complete accord with barometric records in other parts of the world. About sixteen hours afterward a second and entirely similar barometric wave appeared, which, however, is to be considered as the arrival of the same wave by the longer circuit over America and Europe. In fact, if we take the difference of the two courses, — the one from the Straits of Sunda to Berlin over the East Indies, and the other over America, — we shall find that to the above velocity of propagation corresponds the delay of sixteen hours in the arrival of the wave by the American route. It thus appears that the entire wave completed the circuit of the earth in a time which must have amounted to thirty-six hours. In fact, thirty-six hours later there did appear in Berlin, in a direction from the East Indies, another perceptible wave corresponding closely to the first one, but somewhat diminished in strength. The corresponding return from America took place in a period of some thirty-four or thirty-five hours. This is brought into agreement with the other period by the consideration that the atmosphere in general has a motion from west to east. A third wave was recognized after an interval of thirty-seven hours from this time. The diminishing strength of the waves prevented the returns of the single waves from being accurately followed, but small variations of an unusual kind are seen in the record until the 4th of September. We can therefore be satisfied that the atmospheric waves caused by the volcanic eruption were powerful enough to make the entire circuit of the earth three or four times, and that in the beginning the variations of pressure amounted to one five-hundredth of the entire

atmospheric pressure. We are thus obliged to recognize the operation of force through which the heated gases and masses of volcanic dust might be carried into very high regions of the atmosphere.

Mr. Baillaud of Toulouse has communicated to the French Academy of science similar observations of the phenomena, from which he concludes the velocity to have been 349 metres per second. This, also, is very nearly the velocity of sound. From the intervals between the waves, he finds that the waves made the circuit of the earth at the average rate of 324 metres per second.

The most important conclusion to be drawn from these extraordinary observations is, that a mass of air or gas of which no one had before formed a conception must have been ejected by the volcano.

— The entomologists of Washington and Baltimore have decided to form an entomological society. A preliminary meeting was held at the house of Dr. C. V. Riley on the evening of Feb. 29, at which Rev. J. G. Morris of Baltimore presided, and Mr. B. P. Mann acted as secretary. A committee was appointed to draw up the necessary regulations, and to call a future meeting for organization.

— A vineyard proprietor near Nîmes, having had several complaints made to him about his wines, requested M. Barthélemy, of the Faculty of sciences at Toulouse, to analyze them for him. In some of them a rather large proportion of arsenic was found, larger than the trace sometimes found in red wines. The wine from one barrel tested contained no arsenic at all, and in this instance the cask containing the wine was a new one: it had not been previously used. The other barrels had been cleaned, after use, with 'drouge,' which, in point of fact, is diluted sulphuric acid; and the sulphuric acid of the central districts of France has of late years contained so much arsenic, that M. Barthélemy has sometimes used it to obtain a supply of that material.

— Mr. Winter Blyth has recently been employed to analyze imported canned fruits (apricots, tomatoes, etc.) in order to ascertain the amount of contamination by metal in them. In twenty-three samples the amounts found, calculated as stannous hydrate, ranged from 1.9 grains to 14.3 grains per pound, the mean amount being 5.2 grains. The juice and fruit in some instances had a metallic taste. Several of the tins showed signs of corrosion. The *Journal of the Society of arts* says, "The little that is known of the action of stannous hydrate may be summed up in a few lines. Doses of about .174 gram per kilogram of body-weight cause, in guinea-pigs, death with signs of intestinal irritation; but with doses smaller than .17 to .2 gram the effects are uncertain, and the animals generally recover. Hence, supposing a man to be affected in the same proportion, he would have to take from three to four drams, or consume at a meal ten pounds of the most contaminate of Mr. Winter Blyth's tinned fruits. But it is not a question of immediate deadliness: it is rather one for inquiry as to the action of small repeated doses continued for a long time.

There is, as may naturally be supposed, no important break in the chain of mounds stretching along the Mississippi valley from its lower regions to Minnesota; for they are very numerous along the river-bluffs up to the mouth of the St. Croix. They are then met with at intervals on the plateaus and headlands of the Mississippi as far north as Little Falls. In like manner they occupy the River St. Croix from its mouth to Yellow River, if not beyond that point. They are also found in abundance on the lower Minnesota River, and continue up that stream to Big Stone Lake, thence along that lake and Lake Traverse, and down the valley of the Red River to beyond Winnipeg in Manitoba. About the geographical centre of Minnesota, and in the westward region adjacent, aboriginal earthworks are often discovered; there being some particularly noticeable ones in Otter Tail county. In the north-eastern quarter of the state, with one or two slight exceptions, we have no authentic account of the existence of any artificial mounds. There are also many mounds around Lake Minnetonka and along Crow River: indeed, there are more or less on nearly every small stream and lake in central and southern Minnesota. The largest one known in the state is situated on the lower end of Dayton's Bluff in St. Paul, its former height being eighteen feet. Another very handsome mound is located in the village of White Bear, near the lake shore: it is conical in form, and thirteen feet high. Occasionally elongated mounds and embankments have been met with that have been termed 'forts;' but definite surveys and much critical examination are required before it

will be safe to adopt the term as expressive of their true character and use.

This indicates how poorly represented is the state of Minnesota in mounds of any kind. The variety and contents give as little satisfaction as the distribution. Mr. Lewis well says, that the "task of thoroughly examining artificial earthworks by excavation is so onerous, and the prospect of finding any thing of material value to pay for it so slight, there being scarcely any thing but the knowledge acquired to compensate the labor, that few persons care to undertake such work for so poor a return."

—The Dorpat Naturforscher-gesellschaft has received by bequest A. Schrenk's collection of Mollusca, which has been named by Mr. S. Clessin, and arranged by Dr. Max Braun. A hundred and eight species of land and fresh-water shells are known to occur in the Baltic provinces, and of these the Dorpat collection now contains eighty-eight.

—Dr. M. Braun has continued his faunal exploration of the Finland Bay, and in connection therewith has studied the physical characteristics of the water. The temperature diminishes, and the amount of salt increases, with the depth; but the water is so shallow that in severe storms the whole is stirred, mixing the colder and saltier water of the bottom with the top layers. The water thus varies greatly, and this fact must have a great influence upon the life in the bay. The observations are being continued by Commander H. von Roth, and, when completed, are to be carefully worked up.

—Zoölogists and microscopists will welcome the two instalments, just appeared, of Bütschli's learned and thorough treatise on the Protozoa, which is to form vol. i. of the new revision of Bronn's classical 'Thierreich.' Parts xx.-xxv., just received, are entirely devoted to the Flagellata. This work is important not only from its intrinsic value, but also because it is the first comprehensive scientific work on the Protozoa ever published, and must, as such, be very efficient in spreading fuller and more correct knowledge concerning this much misunderstood group of animals. The utter lack of conciseness is the worst, and, at the same time, a serious and inexcusable, defect of this invaluable volume.

—In the *American journal of science and arts*, vol. xxxiii., 2d series, p. 276, a letter from Rev. George Jones, U.S.N., to Professor Silliman, written at Quito, Ecuador, Dec. 13, 1856, describes a fall of ashes from Cotopaxi, which was thirty miles distant, in which a purple sky was noted. The paragraph in which the mention is made runs as follows: "Yesterday morning we noticed that at the south the sky had an unusual appearance, being of a purple color for about 90° along the horizon, and so up to about 45° in height, the edge of this being mixed up with patches of white. About 12 o'clock ashes began to fall, first in small quantities; but by 8 o'clock the fall had got to be so considerable as to powder the clothes quickly, on our going out: and people coming into a house would look as we do at home when coming in from a snow-storm."

—The Amherst college scientific association, organized in 1883, has for an object the promotion of scientific knowledge among its members. It consists of the heads of the scientific departments of the faculty as honorary members, and of active members chosen by the association, at the close of the year, from the members of the junior class recommended by the faculty. At present the membership is limited to twelve. Meetings are held weekly, and consist either of an address by some member of the faculty upon scientific subjects, or a paper read by one of the members, followed by questions and discussions. During the present year the society has listened to President Seelye, on science; Dr. Hitchcock, on social science; Professors Todd, on mountain observatories; Emerson, on the state of geology one hundred years ago; Tyler, on the biblical idea of nature; and Pond, on student-life in Germany. Some of the papers read thus far, by members of the association, are on the relation of chemistry to civilization, the Iatro age of chemistry, eggs, alchemy, the phlogistic theory, the condensation of gases, state of ornithology a hundred years ago, the nebular hypothesis, and proofs of the antiquity of man in the eastern United States.

—M. J. Deniker has prepared for the *Revue d'ethnographie* a sketch of the Ghiliaks, who live about the mouth of the Amoor River, based chiefly on the elaborate works of Schrenk and Seeland, published in St. Petersburg, the former in 1881, the latter in 1882. The Ghiliaks are mentioned for the first time by Witsen (1707); but they have been visited by Russian travellers since, although several distinguished ethnographers have confounded them with the Ainos, Tunguses, etc. The word 'Ghiliak' is a Russian corruption of the Tunguse word 'Kilé.' The people call themselves Niback. Their country is quite restricted. Their villages are sparsely scattered along the valley of the lower Amoor to the Okhotsk Sea. The Olchias, a Tunguse tribe, adjoin them on the south: the Samagheres, of the same stock, are on the west. Besides the valley and the mouth of the Amoor, the Ghiliaks people the neighboring shore of the Okhotsk Sea. Beyond the Tatar Straits, they are found all along the northern part of Saghalin, the southern part being peopled by the Ainos. According to Schrenk, they form, together with Yukagirs, Ainos, Kamtchadals, Koriaks, Chukchis, and Eskimo (extant), and Ostyaks (disappearing), and Omoks, Anaules, Kottes, etc. (disappeared), the family of Palaesiatics, who have been pushed back by the later invading Mongoloids. The average height is 1.62 m. for males, 1.50 m. for females. They are dolichocephalic (76.5). M. Deniker gives detailed descriptions of their measurements, physiognomy, maladies, and character; their food, meals, habitations, house-keeping, clothing, occupations (both of men and women), arms, and transportation; their marriages, polygamy, cremation, religion, myths, and language. A singular custom exists of betrothing children at five or six years of age, in which case the father of the husband adopts the girl, and keeps her until the marriage takes place. After the death of a husband, the wife marries the husband's brother, although she

may decline if she please. The Ghiliaks burn their dead; while the Olthas and Orotches suspend theirs from the trees, or bury them. Their superstitions and religious practices are very interesting, especially the *fête* of the bear, which takes place in January, and lasts fifteen days.

—Mr. J. G. Vassar has given an additional ten thousand dollars to Vassar college for the better support of the chemical and physical departments of the Vassar brothers' laboratory.

—A prize of five thousand pounds was offered by the Indian government for the best machine for the treatment of rhea fibre. In 1869 a Mr. Greig of Edinburgh made a machine for this purpose; but it did not fulfil the conditions laid down, so the full prize was not awarded. Another competition took place, but was unsuccessful. Some rhea fibre experimented on in 1852 by Dr. Forbes Royle was in strength, as compared with St. Petersburg hemp, in the ratio of 280 to 160, while the wild rhea from Assam was as high as 343. Rhea has the widest range of possible applications of any fibre, as shown by an exhaustive report on the preparation and use of rhea fibre by Dr. Forbes Watson. Last year, however, says the *Engineer*, witnessed the solution of the question of decortication in the green state in a satisfactory manner by Mr. A. Favier's process. This process consists in subjecting the plant to the action of steam for a period varying from ten to twenty-five minutes, according to the length of time the plant had been cut. After steaming, the fibre and its adjuncts were easily stripped from the wood. Mr. Favier's process greatly simplified the commercial production of the fibre up to a certain point; but it still stopped short of what was required, in that it delivered the fibre in ribands, with its cementitious matter and outer skin attached. Various methods of removing this were tried without success, until a year ago the whole case was submitted to the distinguished French chemist, Professor Frémy, member of the Institute of France. Professor Frémy carefully investigated the nature of the various substances, and found that the vasculose and pectose were soluble in an alkali under certain conditions, and that the cellulose was insoluble. He therefore dissolves out the cutose, vasculose, and pectose by a very simple process, obtaining the fibre clean, and free from all extraneous adherent matter, ready for the spinner.

—An account and hysometric chart are published by Alfred Grandidier of the district of Madagascar, occupied by the so-called Hovas, whose stout resistance to the French has recently attracted much attention. The country is very different from one's preconceived ideas of a tropical island. The word 'Hova,' it seems, refers only to the middle class of the nation, properly called 'Antai-merina,' or 'Merinas,' in contradistinction to the other two classes of nobles and slaves. The superior intelligence and discipline of the Me ina race have enabled them to conquer, during the present century, most of the tribes which inhabit that immense island. The district which they specially inhabit is called 'Imerina.' It is a moun-

tainous country, completely destitute of trees and shrubs, and often uncultivated. The higher parts are hardly inhabited, but the valleys and lowlands sustain a dense population. The hills, which are composed of masses of granite and dense red clay, are not fertile; but the smallest valleys, when their situation permits, are transformed into rice-fields by the intelligent and industrious natives. West of the capital, there is a large plain twenty miles square, once a lake or marsh, but now one huge rice-field, which presents a beautiful appearance in the wet season, with little hamlets or large houses rising out of it here and there like islands. Other vegetables and fruits of a sub-tropical character are cultivated with moderate success on the hillsides. In the southern part is an assemblage of peaks reaching to eight or nine thousand feet above the sea. From the highest of these the entire district is visible, and appears like a sea of barren mountains destitute of shrubs or trees, and with numerous detached rocks amid coarse grasses not suitable for cattle, and only useful for fuel. Only the rich can afford to send for fagots to a limited strip of woodland which borders the district on the east. Even the dry grass used by the people for cooking becomes very dear in the rainy season; a single fire, perhaps, costing twelve cents. The population of the district reaches a million, and of Antananarivo, the capital, one hundred thousand. The villages are usually built on the summits of hills, and surrounded by a ditch. They contain for the most part but a few dwellings of inexpensive character, and are near the cultivated rice-lands of their owners, which are very valuable, in some places worth eight thousand dollars an acre. The houses are of an oriental character, commonly with one door and one window opening westward to avoid the raw south-east winds. The houses are arranged quite irregularly, and generally are not very clean. The roads are mere footpaths, and, notwithstanding the multiplicity of water-courses, bridges are very rare.

The people are somewhat smaller than those of other Malagasy tribes, but full of energy and intelligence, and in spite of faults peculiar to barbarism, from which they are only just emerging, exhibit industry, economy, and relative sobriety. In these qualities the other tribes cannot be compared with them. They have large families, though the Merina women are said to become sterile if they leave the mountains for the coast. Manufactures have made but little progress, and are chiefly due to white instruction. The rainy season commences toward the end of November, and lasts until March; but there are few severe storms, except during the period from Dec. 15 to Feb. 25.

—In a paper in the Bulletin of the Moscow society of naturalists upon periodic oceanic oscillations, Trautschold attacks the problem of oceanic alterations of level, and their relations to geological phenomena. His conclusions, based upon a careful study of the past and present physiography of eastern and central Europe and western Asia, are to the effect that many of the phenomena of sedimentation and

deposition attributed by geologists to a subsidence of the crust, are, in fact, due to periodic oscillations, or upheavals of the oceanic surface, producing thereby inundations of the land-masses; and that such is the nature of much of the newer sedimentations, e.g., Jurassic of Russia. The position here maintained, a revival of the views of many of the older geologists, is anticipated by Professor Edouard Suess, who, in his 'Antlitz der Erde' (Prague, 1883), clearly indicates the necessity of invoking the assistance of periodic oceanic fluctuations of level to account for the existence of much that has been heretofore attributed to terrestrial subsidence.

—The seventh Saturday lecture in the National museum was on Feb. 16, by Prof. E. D. Cope, on the 'Origin of human physiognomy and character,'—a discourse the main features of which have already been published in the *American naturalist*. On Feb. 23, Mr. John Murdock, late of the signal-service party at the Oglaamie station, North Alaska, gave a very vivid account of 'Eskimo life at Point Barrow.'

—Mr. E. R. Quick has presented to the Brookville (Ind.) society of natural history his entire collection of birds, numbering several hundred specimens, mostly North American. This is one of the largest and best-arranged collections in the state. The society is this year providing a course of free lectures upon popular scientific subjects for the benefit of the citizens of its town. Five of the lectures have been given, and three more are to follow at intervals of three weeks. The last was given by Prof. Jos. F. James of Cincinnati, upon 'Flowers and insects.'

—The museum of comparative zoölogy has published another of its useful 'selections from embryological monographs,' intended to bring together illustrations from the most authentic sources of the early stages of development of various groups of animals. This one is concerned with the Echinodermata, and is compiled by Mr. Alexander Agassiz. It consists of fifteen excellently executed quarto plates, crowded with figures, and accompanied by very simple explanatory text, the bibliography of the subject having already appeared in an octavo form. The protozoa, aculephs, polyps, fishes, and reptiles are announced as in course of preparation.

—All students interested in the study of the brachiopods will be pleased to learn that the last parts of the series of superb monographs of Thomas Davidson, on British fossil Brachiopoda, are completed by the author, and are now in the printer's hands. In a letter received by a correspondent a few days since, from Mr. Davidson, he says that "after thirty-three years of hard labor, in connection with British recent and fossil species, I this year complete my large work; and, indeed, the whole remaining manuscript is in the printer's hands, and being printed. This last part includes, 1, an appendix to the supplements, with plates; 2, an elaborate general summary, with numerous illustrations of the progress of science in connection with the Brachiopoda from 1606 up to the end of 1883; 3, a catalogue of all the British species

of the class, some eight hundred and sixty in number, with geologic distribution in time, and full references; 4, a brachiopod bibliography, which I have been compiling during the last forty years. I have some four thousand entries; and it will, I feel sure, prove to be very useful for references. I began it at 1606, and continued it up to the end of 1883." Of the value and character of this great work, this is not the place to speak; but we cannot refrain from expressing feelings of gratitude, respect, and honor to the man who has given his time and means to prepare for publication a work that reflects so much credit on modern science, especially the division of invertebrate paleontology. Mr. Davidson is now in the sixty-seventh year of his age; and we trust that many useful years still remain to him, in which he may contribute information from his studies upon the Brachiopoda of other countries than Great Britain.

—According to the San Diego papers, a large stone lance-head of Eskimo fashion was found deeply embedded in the tissues of a whale taken at the whaling-station on Ballast Point, near the harbor. The species is not named, but the creature was probably *Megaptera versabilis*. The migrations of the California gray whale, *Rhachianectes glaucus*, are well known, though it is not hunted by the Eskimo; but those of the other species have been less clearly made out, and facts of this sort are worth putting on record.

—Charles Ashford continues his investigations of the *Spicula amoris* in British Helicidae. He examined *Zonites excavatus* and *Z. nitidus*. Until recently the latter was supposed to be the sole member of its genus which possessed a dart: now the former keeps it company. The arrangement of the secreting-organs is remarkably like that of *Zonites intertextus* and *suppressus*, as figured by Leidy. The dart is found in a very small percentage of the total number of adults examined. On the other hand, in *Helix virgata* ninety-five per cent of the adults examined have furnished darts.

—Dr. Benjamin Sharp, the professor of invertebrate zoölogy in the Academy of natural sciences of Philadelphia, will be inaugurated on Tuesday evening, March 18, on which occasion he will deliver a lecture on 'Methods of biological investigation in Europe.' Professor Sharp's course on biology will begin on Thursday, March 20, at 4.15 P.M.

—Dr. D. G. Brinton, the newly elected professor of ethnology and archeology, will deliver a course of lectures in April, introductory to an extended the thorough course to begin next autumn. The subjects of the spring series are as follows: 'Prehistoric man in the new world,' 'Origin of the Aryan races,' 'The study of ethnology in the United States,' and 'The civilized races of America.'

—Two of the naval ensigns pursuing a scientific course at the National museum, Mr. Harlow and Mr. Dresel, have been ordered to the Greely relief expedition.